APPENDIX A

GLOSSARY OF TERMS AND ACRONYMS/ABBREVIATIONS

A-Weighted Sound Level (dBA). A number representing the sound level which is frequency weighted according to a prescribed frequency response established by the American National Standards Institute (ANSI S1.4-1971) and accounts for the response of the human ear.

Acoustics. The science of sound which includes the generation, transmission, and effects of sound waves, both audible and inaudible.

Advisory Council on Historic Preservation. A 19-member body appointed, in part, by the President of the United States to advise the President and Congress and to coordinate the actions of federal agencies on matters relating to historic preservation, to comment on the effects of such actions on historic and archaeological cultural resources, and to perform other duties as required by law (Public Law 89-655; 16 U.S. Code 470).

Aerozine-50. A toxic, colorless liquid propellant that is spontaneously hypergolic in combination with nitric acid and concentrated hydrogen peroxide.

Aesthetics. Referring to the perception of beauty.

Aggregate. Materials such as sand, gravel, or crushed stone used for mixing with a cementing material to form concrete or alone as railroad ballast or graded fill.

Air basin. A region within which the air quality is determined by the meteorology and emissions within it with minimal influence on and impact by contiguous regions.

Albedo. The fraction of incident light or electromagnetic radiation that is reflected by a surface or body (such as the moon or a cloud).

Ammonium perchlorate (NH_4ClO_4). All of the perchlorates produce hydrogen chloride and other chlorine compounds when combined and combusted with other fuels. The exhaust gases are highly corrosive and toxic.

Anomaly. Any deviation from the characteristics of a normal launch.

Apogee. The point in the orbit that is farthest from the Earth.

Aquifer. The water-bearing portion of subsurface earth material that yields or is capable of yielding useful quantities of water to wells.

Archaeology. A scientific approach to the study of human ecology, cultural history, and cultural process.

Area of Concern. A location where contamination is likely or suspected, but where further investigation is needed to confirm its presence and whether it is below action levels.

Area of Potential Effect. The geographic area within which direct and indirect impacts generated by the Proposed Action and alternatives could reasonably be expected to occur and thus cause a change in the historic, architectural, archaeological, or cultural qualities possessed by the property.
Asbestos. A carcinogenic substance formerly used widely as an insulation material by the construction industry; often found in older buildings.

Asbestos-containing material (ACM). Any material containing more than 1 percent asbestos.

Attainment area. A region that meets the National Ambient Air Quality Standards for a criteria pollutant under the Clean Air Act (CAA).

Attitude. The position of an aircraft or spacecraft determined by the relationship between its axes and a reference datum (such as the horizon or a particular star).

Average annual daily traffic (AADT). For a one-year period, the total volume passing a point or segment of a highway facility in both directions, divided by the number of days in the year.

Average daily traffic (ADT). The typical 24-hour volume of traffic passing a given point or segment of a roadway in both directions.

Avionics. The science and technology of electronics applied to aeronautics and astronautics.

Azimuth. Horizontal direction expressed as the angular distance between the direction of a fixed point and the direction of the object; an arc of the horizon measured between a fixed point and the vertical circle passing through the center of an object.

Biophysical. Pertaining to the physical and biological environment, including the environmental conditions crafted by man.

Biota. The plant and animal life of a region.

Candidate species. A species of plant or animal for which there is sufficient information to indicate biological vulnerability and threat, and for which proposing to list as “threatened” or “endangered” is or may be appropriate.

Capacity. The maximum rate of flow at which vehicles can be reasonably expected to traverse a point or uniform segment of a lane or roadway during a specified time period under prevailing roadway, traffic, and control conditions.

Carbon monoxide (CO). A colorless, odorless, poisonous gas produced by incomplete fossil fuel combustion. One of the six pollutants for which there is a national ambient air quality standard. See Criteria pollutants.

Census tract. Small, relatively permanent statistical subdivisions of a county that are delineated for all metropolitan areas and other densely populated counties.

Class I, II, and III Areas. Area classifications, defined by the Clean Air Act, for which there are established limits to the annual amount of air pollution increase. Class I areas include international parks and certain national parks and wilderness areas; allowable increases in air pollution are very limited. Air pollution increases in Class II areas are less limited, and are least limited in Class III areas. Areas not designated as Class I start out as Class II and may be reclassified up or down by the state, subject to federal requirements.

Clean Air Act (CAA). (42 U.S. Code 7401 et seq.) Establishes (1) national air quality criteria and control techniques (Section 7408); (2) National ambient air quality standards (Section 7409); (3) state implementation plan requirements (Section 4710); (4) federal performance standards for stationary sources (Section 4711); (5) national emission standards for hazardous air pollutants (Section 7412); (6) applicability of CAA to federal facilities (Section 7418), i.e., federal agency must comply with federal, state, and local requirements respecting control and abatement of air pollution, including permit and other procedural requirements, to the same extent as any person; (7) federal new motor vehicle emission standards (Section 7521); (8) regulations for fuel (Section 7545); (9) aircraft emission standards (Section 7571).

Clean Water Act. (33 U.S. Code 1251 et seq.) Restores and maintains the chemical, physical, and biological integrity of the nation’s waters.

Coastal sage scrub. A plant community of low, soft-woody, perennial subshrubs (growing to about 1 meter in height) dominated by California sage brush and California brittlebush. Plant growth is most active during the winter and early spring months.

Commodity Connection Building. All fuel and gas lines are routed into this building to provide on-pad fueling of the vehicle.

Community of Comparison (COC). A regional political jurisdiction identified to allow comparison of smaller political units in order to determine the potential for environmental justice impacts (i.e., disproportionately high and adverse impacts to low-income and/or minority populations).

Comprehensive Plan. A public document, usually consisting of maps, text, and supporting materials, adopted and approved by a local government legislative body, which describes future land uses, goals, and policies.

Contaminants. Undesirable substances rendering something unfit for use.

Council on Environmental Quality (CEQ). Established by the National Environmental Policy Act (NEPA), the CEQ consists of three members appointed by the President. A CEQ regulation (Title 40 Code of Federal Regulations [CFR] 1500-1508, as of July 1, 1986) describes the process for implementing NEPA, including preparation of environmental assessments and environmental impacts statements, and the timing and extent of public participation.

Criteria pollutants. The Clean Air Act required the U.S. Environmental Protection Agency (EPA) to set air quality standards for common and widespread pollutants after preparing “criteria documents” summarizing scientific knowledge on their health effects. Today there are standards in effect for six “criteria pollutants”: sulfur dioxide (SO_2), carbon monoxide (CO), particulate matter equal to or less than 10 microns in diameter (PM_{10}), nitrogen dioxide (NO_2), ozone (O_3), and lead (Pb).

Cultural resources. Prehistoric and historic districts, sites, buildings, objects, or any other physical evidence of human activity considered important to a culture, subculture, or a community for scientific, traditional, religious, or any other reason.

Cumulative impact. The impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time.

Day-Night Average Sound Level (DNL). The 24-hour average-energy sound level expressed in decibels, with a 10-decibel penalty added to sound levels between 10:00 p.m. and 7:00 a.m. to account for increased annoyance due to noise during night hours.

Decibel (dB). A unit of measurement of a logarithmic scale which describes the magnitude of a particular quantity of sound pressure or power with respect to a standard reference value.

Deflagration. A launch failure in which the fuel from all stages is explosively burned, resulting in a hot, buoyant ground cloud that is dispersed in the first 10,000 feet.

Dobsen Unit. A unit of measurement used for atmospheric ozone, presented in milliatmosphere centimeters.

Effluent. Waste material discharged into the environment.

Endangered species. A species that is threatened with extinction throughout all or a significant portion of its range.

Endangered Species Act. (16 U.S. Code 1531 et seq.) Provides for listing and protection of animal and plant species identified as in danger, or likely to be in danger, or extinction throughout all or a significant part of their range. Section 7 places strict requirements on federal agencies to protect listed species.

Environmental Impact Analysis Process. The process of conducting environmental studies as outlined in Air Force Instruction 32-7061.

Environmental Justice. An identification of potential disproportionately high and adverse impacts on low-income and/or minority populations that may result from proposed federal actions (required by Executive Order 12898).

Erosion. Wearing away of soil and rock by weathering and the actions of surface water, wind, and underground water.

Evolved Expendable Launch Vehicle (EELV) systems. For the purposes of this document, EELV systems consist of one or more families of vehicles that could replace Atlas IIA, Delta II, and Titan IVB launch vehicles.

Executive Order 12898. Issued by the President on February 11, 1994, this Executive Order requires federal agencies to develop implementation strategies, identify low-income and minority populations that may be disproportionately impacted by proposed federal actions, and solicit the participation of low-income and minority populations.

Explosive safety quantity-distance. The quantity of explosive material and distance separation relationships providing defined types of protection. These relationships are based on levels of risk considered acceptable for the stipulated exposures. Separation distances are not absolute safe distances but are relatively protective or safe distances.

Fault. Fracture in Earth's crust accompanied by a displacement of one side of the fracture with respect to the other and in direction parallel to the fracture.

Fault zone. An area where rupture and subsequent motion has produced rock that is badly crushed. This area may be many feet thick, providing a conduit for the relatively easy passage of fluids.

Floodplain. The lowland and relatively flat areas adjoining inland and coastal waters including flood-prone areas of offshore islands. Includes, at a minimum, that area subject to a 1 percent or greater chance of flooding in any given year (100-year floodplain).

Forbs. Low-growing, non-woody plants other than grass.
Fragmentation. Process by which an orbiting space object disassociates and produces debris.

Frequency. The time rate (number of times per second) that the wave of sound repeats itself, or that a vibrating object repeats itself, now expressed in Hertz (Hz), formerly in cycles per second (cps).

Friable. Easily crumbled or reduced to powder.

Fungicide. Any substance that kills or inhibits the growth of fungi.

Geostationary Earth orbit. Geostationary Earth orbit is a type of geosynchronous Earth orbit in which the object orbits above the Earth's equator at an angular rotation speed equal to the rotation of the Earth, thus appearing to remain stationary with respect to a point on the equator.

Geosynchronous Earth orbit. Geosynchronous Earth orbit occurs at an altitude of 22,238 miles and has an orbital period of approximately 24 hours.

Groundwater. Water within the earth that supplies wells and springs.

Groundwater basin. Subsurface structure having the character of a basin with respect to collection, retention, and outflow of water.

Groundwater recharge. Absorption and addition of water to the zone of saturation.

Hazardous materials/hazardous wastes. Those substances defined as hazardous by the Comprehensive Environmental Response, Compensation and Liability Act, as amended, and the Solid Waste Disposal Act, as amended by the Resource Conservation and Recovery Act, as amended. Generally, this includes substances that, because of their quantity, concentration, or physical, chemical, or infectious characteristics, may present substantial danger or public health or welfare or the environment when released into the environment.

Herbicide. A pesticide, either organic or inorganic, used to destroy unwanted vegetation, especially various types of weeds, grasses, and woody plants.

Historic properties. Under the National Historic Preservation Act, these are properties of national, state, or local significance in American history, architecture, archaeology, engineering, or culture, and worthy of preservation.

Hydrazine (N_2H_4). A toxic, colorless liquid propellant that is spontaneously hypergolic in combination with nitric acid and concentrated hydrogen peroxide. Vapors may form explosive mixtures with air.

Hydrocarbons (HC). Any of a vast family of compounds containing hydrogen and carbon. Used loosely to include many organic compounds in various combinations; most fossil fuels are composed predominantly of hydrocarbons. When hydrocarbons mix with nitrogen oxides in the presence of sunlight, ozone is formed; hydrocarbons in the atmosphere contribute to the formation of ozone.

Hydroxyl-terminated polybutadiene. A polymer binder used in composite propellants.

Hypergolic. Igniting upon contact of components without external aid; of, relating to, or using hypergolic fuel.

Impacts (effects). An assessment of the meaning of changes in all attributes being studied for a given resource; an aggregation of all the adverse effects, usually measured using a qualitative and nominally subjective technique. In this EIS, as well as in the CEQ regulations, the word impact is used synonymously with the word effect.

Inclination. Angle between the orbital plane of a space object and the plane of the Earth's equator.

Indirect impacts. Indirect effects, which are caused by the action and are later in time or farther removed in distance, but are still reasonably foreseeable. Indirect effects may include growth-inducing effects and other effects related to induced changes in the pattern of land use, population density or growth rate, and related effects on air and water and other natural systems, including ecosystems.

Infrastructure. The basic installation and facilities on which the continuance and growth of a community or state (e.g., roads, schools, power plants, transportation, communication systems) are based.

Installation Restoration Program (IRP). The Air Force program designed to identify, characterize, and remediate environmental contamination on Air Force installations. Although widely accepted at the time, procedures followed prior to the mid-1970s for managing and disposing of many wastes often resulted in contamination of the environment. The program has established a process to evaluate past disposal sites, control the migration of contaminants, and control potential hazards to human health and the environment. Section 211 of Superfund Amendments and Reauthorization Act (SARA), codified as the Defense Environmental Restoration Program (DERP), of which the Air Force IRP is a subset, ensures that DoD has the authority to conduct its own environmental restoration programs. DoD coordinates IRP activities with the U.S. EPA and appropriate state agencies.

Jurisdictional wetlands. Those wetlands that meet the hydrophytic vegetation, hydric soils, and wetland hydrology criteria under normal circumstances (or meet the special circumstances as described in the U.S. Army Corps of Engineers, 1987, wetland delineation manual where one or more of these criteria may be absent and are a subset of “Waters of the United States”).

L_{eq}. The equivalent steady-state sound level, which, in a stated period of time, would contain the same acoustical energy as time-varying sound level during the same period.

L_{max}. The highest A-weighted sound level observed during a single event of any duration.

Lead (Pb). A heavy metal used in many industries which can accumulate in the body and cause a variety of negative effects. One of the six pollutants for which there is a national ambient air quality standard.

Lead-based paint. Paint on surfaces with lead in excess of 1.0 milligram per square centimeter as measured by X-ray fluorescence detector or 0.5 percent lead by weight.

Level of service (LOS). In transportation analysis, a qualitative measure describing operational conditions within a traffic stream and how they are perceived by motorists and/or passengers.

Liquid ammonia (NH_3). A liquid propellant that is toxic before combustion or mixing with oxygen, but the exhaust gases produced are non-toxic.

Liquid hydrogen (LH_2). A liquid propellant that has a boiling point of -253.33°C (-424°F), and that requires large, bulky tanks and special materials designed to withstand extremely low temperatures. Mixtures of LH_2 and solid oxygen are explosive. It is the lightest and coldest of all known fuels.

Liquid oxygen (LO_2). A liquid oxidizer that can detonate in combination with organic materials on impact and will accelerate combustion of other materials. Although it will not combust spontaneously with organic materials at ambient temperatures, ignitions or explosions will occur when confined mixtures of oxygen and organic materials undergo sudden pressurization.

Loudness. The qualitative judgment of intensity of a sound by a human being.

Low Earth orbit (LEO). Low-earth orbit occurs at altitudes less than 1,243 miles with an orbital period of 127 minutes or less. Most space activity, particularly commercial, has occurred within this orbital regime.

Low-income. Low-income populations, as used in this EIS, refer to those people with an income below the poverty level ($12,764 for a family of four in 1989, as reported in the 1990 Census of Population and Housing).

Medium Earth orbit. Medium Earth orbit occurs between low and geosynchronous Earth orbits and is a semi-synchronous orbit with a period of approximately 12 hours.

Mineral. Naturally occurring inorganic element or compound.

Mineral resources. Mineral deposits that may eventually become available, known deposits not recoverable at present or yet undiscovered.

Minority. Minority populations, as reported in the 1990 Census of Population and Housing, includes Black; American Indian; Eskimo, or Aleut; Asian or Pacific Islander; Hispanic; or other.

Mitigation. A method or action to reduce or eliminate program impacts.

Monomethyl hydrazine (MMH). A toxic, colorless liquid that is capable of spontaneous ignition when in contact with nitric acid and concentrated hydrogen peroxide. It is a strong reducing agent that tends to react violently with oxidizing agents and is hypergolic with several rocket oxidizers.

National Ambient Air Quality Standards (NAAQS). Section 109 of the Clean Air Act requires the U.S. EPA to set nationwide standards, the NAAQS, for widespread air pollutants. Currently, six pollutants are regulated by primary and secondary NAAQS: carbon monoxide (CO), lead (Pb), nitrogen dioxide (NO_2), ozone, particulate matter equal to or less than 10 microns in diameter (PM_{10}), and sulfur dioxide (SO_2).

National Environmental Policy Act. Public Law 91-190, passed by Congress in 1969. The Act established a national policy designed to encourage consideration of the influences of human activities (e.g., population growth, high-density urbanization, industrial development) on the natural environment. NEPA also established the Council on Environmental Quality (CEQ). NEPA procedures require that environmental information be made available to the public before decisions are made. Information contained in NEPA documents must focus on the relevant issues in order to facilitate the decision-making process.

National Historic Preservation Act (NHPA). (16 U.S.C. 470) Provides for an expanded national Register of Historic Places (NRHP) to register districts, sites, buildings, structures, and objects significant to American history, architecture, archaeology, and culture. Section 106 requires that the President's Advisory Council on Historic Preservation be afforded an opportunity to comment on any undertaking that adversely affects properties listed in the NRHP.

National Priority List (NPL). A list of sites (federal and state) where releases of hazardous materials may have occurred and may cause an unreasonable risk to the health and safety of individuals, property, or the environment.

National Register of Historic Places (National Register). A register of districts, sites, buildings, structures, and objects important in American history, architecture, archaeology, and culture, maintained by the Secretary of the Interior under authority of Section 2 (b) of the Historic Sites Act of 1935 and Section 101 (a)(1) of the National Historic Preservation Act of 1966, as amended.

Native Americans. Used in a collective sense to refer to individuals, bands, or tribes who trace their ancestry to indigenous populations of North America prior to Euro-American contact.

Native vegetation. Plant life that occurs naturally in an area without agricultural or cultivational efforts. It does not include species that have been introduced from other geographical areas and have become naturalized.

Nitrogen dioxide (NO_2). Gas formed primarily from atmospheric nitrogen and oxygen when combustion takes place at high temperature. Nitrogen dioxide emissions contribute to acid deposition and formation of atmosphere ozone. One of the six criteria pollutants for which there is a national ambient air quality standard.

Nitrogen oxides (NO_x). Gases formed primarily by fuel combustion, which contribute to the formation of acid rain. Hydrocarbons and nitrogen oxides combine in the presence of sunlight to form ozone, a major constituent of smog.

Nitrogen tetroxide (N_2O_4). A liquid oxidizer that can cause spontaneous ignition with many common materials such as paper, leather, or wood. It also forms strong acids in combination with water, and contact can cause severe chemical burns. It is a yellow-brown liquid which is easily frozen or vaporized.

Nodal period. Elapsed time between either of the points at which the orbit of an object crosses the plane of the equator.

Noise attenuation. The reduction of a noise level from a source by such means as distance, ground effects, or shielding.

Noise contour. A line connecting points of equal noise exposure on a map. Noise exposure is often expressed using the day-night average sound level.

Nonattainment area. An area that has been designated by the U.S. EPA or the appropriate state air quality agency as exceeding one or more national or state ambient air quality standards.

Orbital debris (space debris). Space objects in Earth orbit that are not functional. Spent rocket bodies, mission-related objects, fragments from breakups and deterioration, non-functional spacecraft, and aluminum particles from solid rocket exhaust are all considered debris.

Ozone (O_3) (ground level). A major ingredient of smog. Ozone is produced from reactions of hydrocarbons and nitrogen oxides in the presence of sunlight and heat. One of the six criteria pollutants for which there is a national ambient air quality standard.

Paleontology. The study of life in past geologic time, based on fossil plants and animals.

Particulate matter equal to or less than 10 microns in diameter (PM_{10}). Solid particles consisting of dust, soot, and various types of chemical species that have been emitted into the atmosphere and can remain suspended for several days or weeks. Particulate matter equal to or less than 10 microns in diameter can be hazardous to human health because it is small enough to penetrate the lung's natural defenses and may contain toxic or other chemicals that present a health concern. One of the six criteria pollutants for which there is a national ambient air quality standard.

PCB-contaminated equipment. Equipment which contains a concentration of polychlorinated biphenyls (PCBs) from 50 to 499 parts per million (ppm). Disposal and removal are regulated by the U.S. EPA.

PCB equipment. Equipment that contains a concentration of PCBs of 500 ppm or greater. Disposal and removal are regulated by the U.S. EPA.

PCB items. Fluids containing 5 to 49 ppm of PCBs. Regulated in California under Title 22, Chapter 30 of the California Code of Regulations and chapter 6.5 of the California Health and Safety Code.

Perigee. The point in the orbit that is closest to the Earth.

Permeability. The capacity of a porous rock or sediment to transmit a fluid.

Pesticide. Any substance, organic or inorganic, used to destroy or inhibit the action of plant or animal pests; the term thus includes insecticides, herbicides, fungicides, rodenticides, miticides, fumigants, and repellants. All pesticides are toxic to humans to a greater or lesser degree. Pesticides vary in biodegradability.

Physiography. The science of the surface of the earth and the interrelations of air, water, and land.

Pleistocene. An earlier epoch of the Quaternary period during the “Ice Age” beginning approximately 3 million years ago and ending 10,000 years ago. Also refers to the rocks and sediments deposited during that time.

Plume. An elongated mass of contaminated fluid moving with the flow of the fluid.

Polychlorinated biphenyls (PCBs). Any of a family of industrial compounds produced by chlorination of biphenyl. these compounds are noted chiefly as an environmental pollutant that accumulates in organisms and concentrates in the food chain with resultant pathogenic (disease-causing) and teratogenic (deformity-causing) effects. They also decompose very slowly.

Potable water. Suitable for drinking.

Prehistoric. The period of time prior to European contact, established in 1769 in the western United States.

Prevention of Significant Deterioration (PSD). In the 1977 Amendments to the Clean Air Act, Congress mandated that areas with air cleaner than required by national ambient air quality standards must be protected from significant deterioration. The Act’s PSD program consists of two elements: requirements for best available control technology on major new or modified sources, and compliance with an air quality increment system.

Primary roads. A consolidated system of connected main roads important to regional, statewide, and interstate travel; they consist of rural arterial routes and their extensions into and through urban areas of 5,000 or more population.

Prime farmland. Environmentally significant agricultural lands protected from irreversible conversion to other uses by the Farmland Protection Policy Act.

Protohistoric. Referring to the study of the time period between European contact and established written history.

Radon. A naturally occurring, colorless and odorless radioactive gas that is produced by radioactive decay of naturally occurring uranium.

Rawinsonde. A meteorological balloon tracked by a radio direction-finding instrument or radar, used for measuring wind speed in the upper atmosphere.

Recent. The time period from approximately 10,000 years ago to the present and the rocks and sediments deposited during that time.

Region of Influence (ROI). The geographical region that would be expected to be affected in some way by proposed action and alternative.

Riparian. Of or on the bank of a natural course of water.

Sediment. Material deposited by wind or water.

Scoping. A process initiated early during preparation of an environmental impact statement to identify the scope of issues to be addressed, including the significant issues related to the proposed action. During scoping, input is solicited from affected agencies as well as the interested public.

Scrubber. An apparatus for removing impurities from a gas.

Seismicity. Relative frequency and distribution of earthquakes.

Sensitive habitat. An area inhabited by rare, threatened, or endangered species; an ecosystem supporting a wide variety of plants, birds, and wildlife.

Site. As it relates to cultural resources, any location where humans have altered the terrain or discarded artifacts.

Solid rocket motor. A rocket motor that uses a solid propellant rather than liquids.

Sound exposure level. The A-weighted sound level integrated over the entire duration of a noise event and referenced to a duration of 1 second.

State Historic Preservation Officer (SHPO). The official within each state, authorized by the state at the request of the Secretary of the Interior, to act as liaison for purposes of implementing the National Historic Preservation Act.

Stratosphere. The part of the atmosphere between the troposphere and the mesosphere, occupying the altitudes from approximately 49,000 feet to 167,000 feet (9 to 31 miles).

Sulfur dioxide (SO_2). A toxic gas that is produced when fossil fuels, such as coal and oil, are burned. SO_2 is the main pollutant involved in the formation of acid rain; it can also irritate the upper respiratory tract and cause lung damage. The major source of SO_2 in the United States is coal-burning electric utilities. One of the six criteria pollutants for which there is a national ambient air quality standard.

Therm. A measurement of units of heat.

Threatened species. Plant and wildlife species likely to become endangered in the foreseeable future.

Total suspended particulates (TSP). The particulate matter in the ambient air. The previous national standard for particulates was based on TSP levels; it was replaced in 1987 by an ambient standard based on levels of particulate matter equal to or less than 10 microns.

Trajectory. The flight path that a spacecraft will take during a mission.

Trichloroethylene (TCE). A colorless, nonflammable, photoreactive liquid, with a chloroform-like odor, which is slightly soluble in water, and toxic when inhaled. TCE is used for metal degreasing, cleaning, and drying electronic parts; extraction processes; and other chemical processes (Chemical Formula CHCl:CCl2.

Unsymmetrical Dimethylhydrazine (UDMH). A derivative of hydrazine, having many of the same characteristics as hydrazine. It forms a more stable liquid than hydrazine at higher temperatures.

U.S. Environmental Protection Agency (EPA). The independent federal agency, established in 1970, that regulates federal environmental matters and oversees the implementation of federal environmental laws.

Wetlands. Areas that are inundated or saturated with surface or groundwater at a frequency and duration sufficient to support a prevalence of vegetation typically adapted for life in saturated soil. This classification includes swamps, marshes, bogs, and similar areas.

Volume. The number of vehicles passing a point on a lane, roadway, or other trafficway during some time interval.

Zoning. The division of a municipality (or county) into districts for the purpose of regulating land use, types of buildings, required yards, necessary off-street parking, and other prerequisites to development. Zones are generally shown on a map, and the text of the zoning ordinance specifies requirements for each zoning category.

ACRONYMS AND ABBREVIATIONS

A-50	Aerozine-50
AADT	average annual daily traffic
ACM	asbestos-containing material
ACO	Aeronautical Control Officer
A.D.	Anno Domini
ADT	average daily traffic
AFB	Air Force Base
AFI	Air Force Instruction
AFM	Air Force Manual
AFPD	Air Force Policy Directive
AF/SG	Air Force Surgeon General
AFSPC	Air Force Space Command
AGL	above ground level
AIRFA	American Indian Religious Freedom Act
Al	aluminum
Al_2Cl_3	aluminum chloride
Al_2O_3	aluminum oxide
AOC	area of concern
APCD	Air Pollution Control District
APCO	Air Pollution Control Officer
APS	Aboveground Petroleum Storage
ARPA	Archaeological Resources Protection Act
AS	Air Station
AST	aboveground storage tank
AWSPL	A-weighted sound pressure level
BAB	Booster Assembly Building
BACT	Best Available Control Technology
B.C.	Before Christ
BEBR	Bureau of Economic and Business Research
C	Celsius
CAA	Clean Air Act
CAAA	Clean Air Act Amendments
CAAQS	California Ambient Air Quality Standards
CAP	Collection Accumulation Point
CARB	California Air Resources Board
CBC	common booster core
CCR	California Code of Regulations
CCTF	Centaur Cryogenic Tanking Facility
CCTV	closed circuit television
CEQ	Council on Environmental Quality
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CERL	Construction Engineering Research Laboratories
CFR	Code of Federal Regulations
cfs	cubic feet per second
Cl	chlorine (atom)
Cl_2	chlorine (molecule)
ClO	hypochlorite
Cl_x	chlorine compounds
cm	centimeter
CMS	Corrective Measures Study
CNEL	Community Noise Equivalent Level
CO	carbon monoxide
CO_2	carbon dioxide
COC	Community of Comparison

COMSTAC	Commercial Space Transportation Advisory Council
CPB	Centaur Processing Building
CPF	Centaur Processing Facility
CPSC	Consumer Product Safety Commission
CSB	common support building
CSLA	Commercial Space Launch Activities
CUS	Cryogenic Upper Stage
CWA	Clean Water Act
CZMA	Coastal Zone Management Act
CZMP	Coastal Zone Management Program
°	degree
DAIP	Danger Area Information Plan
dB	decibel
dBA	A-weighted decibel
DCG	Disaster Control Group
DCUS	Delta Cryogenic Upper Stage
DEIS	draft environmental impact statement
DERP	Defense Environmental Restoration Program
DHUS	Delta II hypergolic upper stage
DIV	Delta IV
DIV-H	heavy launch vehicle
DIV-M	medium launch vehicle
DIV-M+	medium launch vehicle with solid rocket motor strap-ons
DIV-S	small launch vehicle
DNL	day-night average noise level
DoD	Department of Defense
DOT	Department of Transportation
DRMO	Defense Reutilization and Marketing Office
DTSC	Department of Toxic Substances Control
EELV	Evolved Expendable Launch Vehicle
EHC	Emission Hazard Corridor
EHS	Environmental Health Services
EIAP	Environmental Impact Analysis Process
EIS	environmental impact statement
EMD	Engineering and Manufacturing Development
ENVVEST	Environmental Investment
EO	Executive Order
EOD	Explosive Ordnance Disposal
EPA	Environmental Protection Agency
ER	Eastern Range
ESMC	Eastern Space and Missile Center
ESQD	Explosive Safety Quantity-Distance
EWR	Eastern and Western Range
F	Fahrenheit
FAA	Federal Aviation Administration
FAAQS	Florida Ambient Air Quality Standards
FAC	Florida Administrative Code
FCMA	Florida Coastal Management Act
FDCA	Florida Department of Community Affairs
FDEP	Florida Department of Environmental Protection
FEIS	final environmental impact statement
FNAI	Florida Natural Areas Inventory
FONPA	Finding of No Practicable Alternatives
FSA	Flight Safety Analyst
ft	feet
FTS	flight termination system
FUT	fixed umbilical tower

FVIS	fuel vapor incineration system
gal	gallons
GEM	Graphite Epoxy Motor
GHe	gaseous helium
GN_2	gaseous nitrogen
GOP	Ground Operations Plan
gpd	gallons per day
gpm	gallons per minute
GSE	ground support equipment
GTO	Geosynchronous Transfer Orbit
H_2	hydrogen
HABS/HAER	Historic American Buildings Survey/Historic American Engineering Record
HAP	hazardous air pollutant
HazMart	hazardous materials pharmacy distribution system
HCl	hydrochloric acid
HDCUS	Heavy Delta Cryogenic Upper Stage
He	helium
HIF	Horizontal Integration Facility
HLV	heavy launch vehicle (Concept B)
HLV	heavy lift variant (Concept A)
HMTA	Hazardous Materials Transportation Act
HNO_3	nitric acid
HQ AFSPC/SG	Headquarters Air Force Space Command/Surgeon General
HSWA	Hazardous and Solid Wastes Amendments
HTPB	hydroxyl-terminated polybutadiene
HUS	Hypergolic Upper Stage
HVAC	heating, ventilation, and air conditioning
HWMP	Hazardous Waste Management Plan
Hz	hertz
ICBM	Intercontinental Ballistic Missile
IIP	Instantaneous Impact Point
in	inch
IPF	Integrated Processing Facility
IRA	Interim Remedial Action
IRP	Installation Restoration Program
ITL	Integrate Transfer Launch
IWTP	industrial wastewater treatment plant
JPC	Joint Propellants Contractor
km	kilometer
KSC	Kennedy Space Center
kW	kilowatt
kWH	kilowatt hours
LBS	Launch Base Support
LCCV	Low-Cost Concept Validation
LDCG	Launch Disaster Control Group
L_{dn}	day-night average noise level
LEO	low Earth orbit
L_{eq}	equivalent noise level
LH_2	liquid hydrogen
LMU	launch mount unit
LN_2	liquid nitrogen
LO_2	liquid oxygen
LOS	level of service
LO_x	liquid oxygen
LST	Launch Support Team
m	meter
M	magnitude

MACT	Maximum Available Control Technology
MARSS	Meteorological and Range Safety Support
MAS	mobile assembly shelter
mb	millibars
MBTU	million British thermal units
MCL	maximum contaminant level
MFCO	Mission Flight Control Officer
MGD	million gallons per day
mg/l	milligrams per liter
$\mu g/m^3$	micrograms per cubic meter
mi	mile
MIS	Missile Inert Storage
MLV	medium launch vehicle (Concept B)
MLV	medium lift variant (Concept A)
mm	millimeter
MMH	monomethyl hydrazine
MMS	Minerals Managaement Service
MOA	Memorandum of Agreement
MOL	Manned Orbital Laboratory
mph	miles per hour
MSL	mean sea level
MSPSP	Missile System Prelaunch Safety Package
MST	Mobile Service Tower
MW	megawatt
MWH	megawatt-hour
N_2H_4	hydrazine
N_2O	nitrous oxide
N_2O_3	nitrogen anhydride
N_2O_4	nitrogen tetroxide
N_2O_5	nitric anhydride
NAAQS	National Ambient Air Quality Standards
NAGPRA	Native American Graves Protection and Repatriation Act
NASA	National Aeronautics and Space Administration
NAS/NRC/COT	National Academy of Science, National Research Council Committee on Toxicology
NCS	nutation control system
NEPA	National Environmental Policy Act
NESHAP	National Emissions Standards for Hazardous Air Pollutants
NFRAP	no further response action planned
NH_4ClO_4	ammonium perchlorate
NHPA	National Historic Preservation Act
NMFS	National Marine Fisheries Service
NMM	National Executable Mission Model
NO	nitric oxide
NO_2	nitrogen dioxide
NO_3	nitrogen trioxide
NO_x	nitrogen oxides
NOAA	National Oceanic and Atmospheric Administration
NOI	Notice of Intent
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
NSPS	New Source Performance Standards
NSR	New Source Review
OBDG	Ocean Breeze Dry Gulf
ODS	Ozone-Depleting Substance
OFW	Outstanding Florida Water
OPlan	Operations Plan

OSHA	Occupational Safety and Health Administration
OSP	Operations Safety Plan
OSPL	overall sound pressure level
OVSS	oxidizer vapor scrubber system
PA/SI	Preliminary Assessment/Site Investigation
Pb	lead
PCB	polychlorinated biphenyl
PEA	Preliminary Endangerment Assessment
PEL	Permissible Exposure Level
PG-2	triethyl boron/triethyl aluminum
pH	hydrogen ion concentration
PHC	Potential Hazard Corridor
PHV	peak-hour volume
P.L.	Public Law
PM	particulate matter
$PM_{2.5}$	particulate matter equal to or less than 2.5 microns in diameter
PM_{10}	particulate matter equal to or less than 10 microns in diameter
POL	petroleum, oil, and lubricants
PPA	Pollution Prevention Act
PPF	Payload Processing Facility
ppm	parts per million
PPMP	Pollution Prevention Management Action Plan
PPPG	Pollution Prevention Program Guide
PSC	polar stratospheric cloud
PSD	prevention of significant deterioration
psf	pounds per square foot
RA	Remedial Action
RCRA	Resource Conservation and Recovery Act
RCS	reaction control system
RDC	Range Operations Commander
REEDM	Rocket Exhaust Effluent Diffusion Model
RF	radio frequency
RFI	RCRA Facility Investigation
RI/FS	Remedial Investigation/Feasibility Study
RIMSII	Regional Input-Output Modeling System
RIS	Rocket Inert Storage
RLCC	Remote Launch Control Center
ROCC	Range Operations Control Center
ROD	Record of Decision
ROI	region of influence
RP-1	kerosene fuel (rocket propellant-1)
RWD	Report of Waste Discharge
RWQCB	Regional Water Quality Control Board
SAP	satellite accumulation point
SARA	Superfund Amendments and Reauthorization Act
SBCAPCD	Santa Barbara County Air Pollution Control District
SCCAB	South Central Coast Air Basin
SEB	Support Equipment Building
SEL	sound exposure level
SHPO	State Historic Preservation Officer
SI	Site Investigation
SIC	Standard Industrial Classification
SIP	State Implementation Plan
SJRWMD	St. John’s River Water Management District
SLC	Space Launch Complex
SLMP	Space Launch Modernization Plan
SMAQMD	Sacramento Metropolitan Air Quality Management District

SMC	Space and Missile Systems Center
SO_2	sulfur dioxide
SPCC	Spill Prevention, Control, and Countermeasure
SPD	System Performance Document
SPF-3	Standardized Plume Flowfield Model
SPTC	Southern Pacific Transportation Company
SR	State Route
SRM	solid rocket motor
SRMU	solid rocket motor upgrade
SSPP	System Safety Program Plan
SUS	Storable Upper Stage
SW	Space Wing
SWMP	Solid Waste Management Plan
SWMU	solid waste management unit
TCE	trichloroethylene
TDK	Two-Dimensional Kinetics
TDRSS	Tracking and Data Relay Satellite System
TDS	total dissolved solids
THA	Toxic Hazards Assessment
THC	toxic hazard corridor
THZ	Toxic Hazard Zones
TNT	trinitrotoluene
TRCP	Toxic Release Contingency Plan
TSCA	Toxic Substances Control Act
TSDF	treatment, storage, or disposal facility
TSP	total suspended particulate
TWA	time-weighted average
UCSB	University of California at Santa Barbara
UDMH	unsymmetrical dimethylhydrazine
U.N.	United Nations
U.S.	U.S. Highway
USACE	U.S. Army Corps of Engineers
U.S.C.	U.S. Code
USCG	United States Coast Guard
USF	Upper Stage Processing Facility
USFWS	U.S. Fish and Wildlife Service
UST	underground storage tank
UV	ultraviolet
V/C	volume-to-capacity
VMT	vehicle miles traveled
VOC	volatile organic compound
VPF	Vehicle Processing Facility
WDR	Waste Discharge Requirement
WR	Western Range
WWTP	wastewater treatment plant

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APPENDIX B

NOTICE OF INTENT

The following Notice of Intent was circulated and published by the Air Force in the February 19, 1997, Federal Register in order to provide public notice of the Air Force's intent to prepare an Environmental Impact Statement for the Evolved Expendable Launch Vehicle (EELV) program. This Notice of Intent has been retyped for clarity and legibility.

NOTICE OF INTENT
TO PREPARE AN ENVIRONMENTAL IMPACT STATEMENT
EVOLVED EXPENDABLE LAUNCH VEHICLE PROGRAM

The Department of the Air Force through Space and Missile Systems Center (SMC/MV) is considering development and deployment of an Evolved Expendable Launch Vehicle (EELV) to meet the U.S. government's requirements for unmanned space launches. The EELV Program Office at Los Angeles Air Force Base (AFB), California, is managing program activities and intends to study the environmental issues associated with the EELV program. To this end, the Air Force Center for Environmental Excellence (AFCEE) will prepare an environmental impact statement (EIS) for use in the decision-making process.

The EELV would be an unmanned, expendable space launch vehicle evolved from existing systems capable of launching Department of Defense (DoD), National Aeronautics and Space Administration (NASA), other government, and civil satellites, including payloads up to 45,000 pounds. It is intended to meet the requirements of the National Mission Model, both medium and heavy lift, at a lower cost than the present expendable systems. EELV would be DoD's sole source of expendable medium and heavy spacelift transportation to orbit through 2020. EELV would replace current Titan II, Titan IV, Atlas II, and Delta II launch vehicles.

EELV launch activities would occur at Cape Canaveral Air Station (AS), Florida, and Vandenberg AFB, California, from existing space launch complexes that would be modified to meet program requirements.

The EELV program decision to be made is whether EELV should proceed into the engineering and manufacturing development phase on through production and launch operations. The EIS will examine continuing use of existing launch systems and facilities as alternatives to the continued development of EELV and its associated facilities.

Scoping will be conducted to identify environmental concerns and issues that need to be addressed in the EIS. Two public scoping meetings will be held as part of the process (one each in Cape Canaveral, Florida, and Lompoc, California) to determine the environmental issues and concerns that should be addressed. The schedule for the scoping meetings is as follows:

DATE	LOCATION	TIME
11 March 1997	Radisson Resort at the Port 8701 Astronaut Blvd Cape Canaveral, Florida	7:00 - 10:00 p.m.
13 March 1997	Lompoc City Council Chambers 100 Civic Center Plaza Lompoc, California	7:00 - 10:00 p.m.

Public input and comments are solicited concerning the environmental aspects of the proposed program. To ensure that the Air Force will have sufficient time to fully consider public input on issues, written comments should be mailed to ensure receipt no later than April 11, 1997.

Comments concerning the proposed project or the EIS should be addressed to:

Jonathan D. Farthing
Chief, Environmental Analysis Division
HQ AFCEE/ECA

3207 North Road
Brooks Air Force Base, Texas 78235-5363
(210) 536-3668

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APPENDIX C

DRAFT ENVIRONMENTAL IMPACT STATEMENT
MAILING LIST

This list of recipients includes interested federal, state, and local agencies and individuals who have expressed an interest in receiving the document, and public outreach agencies identified during the environmental justice analysis. This list also includes the governors of Florida and California, as well as United States senators and representatives and state legislators.

ELECTED OFFICIALS

Federal Officials - State of Florida

U.S. Senate

The Honorable Robert Graham
The Honorable Connie Mack

U.S. House of Representatives

The Honorable David Weldon

Federal Officials - State of California

U.S. Senate

The Honorable Barbara Boxer
The Honorable Dianne Feinstein

U.S. House of Representatives

The Honorable Walter Capps

State of Florida Officials

Governor

The Honorable Lawton Chiles

Senate

The Honorable Charlie Bronson
The Honorable Patsy Ann Kurth

State of Florida Officials (Continued)

Assembly

The Honorable Randy Ball
The Honorable Howard Futch
The Honorable Harry C. Goode, Jr.
The Honorable Bill Posey

State of California Officials

Governor

The Honorable Pete Wilson

Senate

The Honorable Jack O'Connell

Assembly

The Honorable Tom Bordonaro
The Honorable Brooks Firestone

Local Officials - Florida

The Honorable Bill Allan
Commissioner, City of Cocoa Beach

The Honorable Larry Bartley
Mayor of Titusville

The Honorable John Blubaugh
Council Member, City of Cocoa

The Honorable John Buckley
Mayor of Melbourne

The Honorable Mark Cook
Brevard County Commissioner, District 4

The Honorable Nancy Higgs
Brevard County Commissioner, District 3

The Honorable Michael Hill
Mayor of Cocoa

The Honorable Anthony Johnson
Commissioner, City of Cocoa Beach

Local Officials - Florida (Continued)

The Honorable James Kelley
Mayor of Melbourne Beach

The Honorable Joseph Morgan
Mayor of Cocoa Beach

The Honorable Randy O'Brien
Brevard County Commissioner, District 2

The Honorable John Porter
Mayor of Cape Canaveral

The Honorable Rocky Randels
Mayor Pro-Tem, City of Cape Canaveral

Charles Rowland, Executive Director
Canaveral Port Authority

The Honorable Truman Scarborough, Jr.
Brevard County Commissioner, District 1

The Honorable Helen Voltz
Brevard County Commissioner, District 5

The Honorable Chuck Wells
Mayor of West Melbourne

Local Officials - California

The Honorable Roger Bunch
Mayor of Santa Maria

The Honorable Joyce Howerton
Mayor of Lompoc

The Honorable Mary Leach
Lompoc Councilwoman

The Honorable Renaldo Pili
Mayor of Guadalupe

The Honorable Mike Siminski
Lompoc Councilman

The Honorable Timothy Staffel
Santa Barbara County Supervisor

Local Officials - California (Continued)

The Honorable George Stillman
Lompoc Councilman

The Honorable Bill Wallace
3rd District

GOVERNMENT AGENCIES

Federal Agencies

Advisory Council on Historic Preservation

Federal Aviation Administration, Office of Commercial Space Transportation

Federal Emergency Management Agency

Department of the Interior
Bureau of Indian Affairs

Department of the Interior
Office of Environmental Policy and Compliance

Environmental Protection Agency

Department of Defense

AFCEE/CCR-A

AFCEE/CCR-S

MAJ Steven H. Boyd
AFOTEC/OL-BC

Regional Offices of Federal Agencies - State of Florida

Department of Commerce
National Marine Fisheries Service
Southeast Regional Office

Department of the Interior
Fish and Wildlife Service, Regional Office
Jacksonville, Florida

Regional Offices of Federal Agencies - State of Florida (Continued)

Department of the Interior
Fish and Wildlife Service
Merritt Island National Wildlife Refuge
Titusville, Florida

Department of the Interior
National Parks
Cape Canaveral National Seashore
Titusville, Florida

Environmental Protection Agency, Region IV
Atlanta, Georgia

Kennedy Space Center

Regional Offices of Federal Agencies - State of California

Department of Commerce
National Marine Fisheries Service
Southwest Regional Office

Department of the Interior
San Francisco, California

Department of the Interior
Fish and Wildlife Service
Ventura, California

Environmental Protection Agency, Region IX
San Francisco, California

State of Florida Agencies

Department of Community Affairs

Department of Natural Resources

Department of State, Division of Historic Resources

East Central Florida Regional Planning Council

Florida Department of Environmental Protection

Florida State Clearinghouse

Game and Fresh Water Commission

State of California Agencies

Cal EPA/DTSC

Cal EPA/DTSC Legislative Analysis

California Air Resources Board

California Department of Fish and Game
Paso Robles, California

California Department of Fish and Game
Sacramento, CA

California Regional Water Quality Control Board

California Resources Agency

Clean Water Action

Environmental Health Services

Federal Programs

Office of Historic Preservation

State Clearinghouse

State Coastal Conservancy

Local Agencies - Cape Canaveral AS

Brevard County Emergency Management

Brevard County Natural Resources

St. John's River Water Management District

Local Agencies - Vandenberg AFB

Economic Development Association

Environmental Health Services

Hazardous Materials Environmental Safety (CAER)

Lompoc Public Works

Local Agencies - Vandenberg AFB (Continued)

Public Safety Department
City of Solvang

San Luis Obispo County Board of Supervisors

Santa Barbara County Air Pollution District

Santa Barbara County Environmental Health Department

Santa Barbara County Fire Department

Santa Barbara Water Agency

Santa Ynez River and Water

Southern California Association of Governments

Water Resources

Libraries - Florida

Cape Canaveral Library

Central Brevard Library

Cocoa Beach Library

Melbourne Library

Merritt Island Library

North Brevard Library

Palm Bay Library

Libraries - California

Lompoc Public Library

San Luis Obispo City/County Library

Santa Maria Public Library

California Polytechnic State University
Robert F. Kennedy Library

Local Agencies - Vandenberg AFB (Continued)

University of California, Santa Barbara
Davidson Library, Reference Services

OTHERS

Other Organizations/Individuals

Federation of American Scientists
Steven Aftergood

Bixby Ranch Co.
John Bauchke

The Boeing Company
Clare Elser

Walter & Bornholdt Law Offices
Kenneth C. Bornholdt

J.B. Kump

Lockheed Martin, Denver, Colorado
Tom Giordano
Edward Rodriguez

Marine Resources Council
Gerald Rosebery, Ph.D.

Micosukee Indian Tribe

Parsons Engineering Science, Inc.
Craig McColloch

Santa Ynez Band of Chumash Indians

Seminole Indian Tribe

Spaceport Florida Authority
Patricia A. Sweetman

Spaceport Systems International
Dominick Barry
Lori Anne Redhair

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Table D-1. Representative Federal Permits, Licenses, and Entitlements
Page 1 of 2

Permit, License, or Entitlement	Typical Activity, Facility, or Category of Persons Required to Obtain the Permit, License, or Entitlement	Authority
Federal		
Clean Air Act (CAA) Title V Permit	Any major source (source that emits more than 100 tons/year of criteria pollutant in a nonattainment area for that pollutant or is otherwise defined in Title I of CAA as a major source); affected sources as defined in Title IV of CAA; sources subject to Section 111 regarding New Source Performance Standards; sources of air toxics regulated under Section 112 of CAA; sources required to have new source or modification permits under Parts C or D of Title I of CAA; and any other source such as Hazardous Waste pollutants designated by U.S. Environmental Protection Agency (U.S. EPA) regulations.	Title V of CAA, as amended by the CAA Amendment
National Pollutant Discharge Elimination System (NPDES) Wastewater permit	Discharge of pollutant from any point source into waters of the United States.	Section 402 of Cl Water Act, 33 U.S Section 1342
NPDES Storm Water Discharge permit	Discharge of storm water during construction projects disturbing 5 acres or more.	
Section 404 (Dredge and Fill) permit	Any project activities resulting in the discharge of dredged or fill material into bodies of water, including wetlands, within the United States.	Section 404 of Cl Water Act, 33 U.S Section 1344; Ch 17-312, Florida Administrative Co (FAC).

Table D-1. Representative Federal Permits, Licenses, and Entitlements
Page 2 of 2

Permit, License, or Entitlement	Typical Activity, Facility, or Category of Persons Required to Obtain the Permit, License, or Entitlement	Authority
Hazardous waste treatment, storage, or disposal (TSD) facility permit	Owners or operators of a new or existing hazardous waste TSD facility.	Resource Conser and Recovery Ac (RCRA) as amen 42 U.S.C. Sectior 6901; Title 40 Co Federal Regulatic (CFR) 270; Chapt 403.704, 403.72 403.8055, Florida Statutes (FS); Ch 17-730.180, FAC
U.S. EPA identification number	Generators or transporters (off-site transport) of hazardous waste.	40 CFR 262.10 (generators); Title CFR Part 263, Su B (transporters)
Archaeological Resources Protection permit	Excavation and/or removal of archaeological resources from public lands or Indian lands and carrying out of activities associated with such excavation and/or removal.	Archaeological Resource Protect Act of 1979, 16 U Section 470cc
Endangered Species Act Section 10 permit	Taking endangered or threatened wildlife species; engaging in certain commercial trade of endangered or threatened plants or removing such plants on property subject to federal jurisdiction.	Section 10 of Endangered Spe Act, 16 U.S.C. Se 1539; Title 50 CF Subparts C, D, F, and G.
Marine Mammal Protection Act	Any project activities resulting in the incidental, but not intentional, taking of marine mammals by United States citizens who engage in specified activities (other than commercial fishing).	16 U.S.C. 1361 e seq.

APPENDIX F

NOISE METHODS OF ANALYSIS

Noise is generally described as unwanted sound. Unwanted sound can be based on objective effects (hearing loss, damage to structures, etc.) or subjective judgments (community annoyance). Noise analysis thus requires a combination of physical measurement of sound, physical and physiological effects, plus psycho- and socioacoustic effects.

Section 1.0 of this appendix describes how sound is predicted and measured. Section 2.0 describes the effect of noise on people, structures, and wildlife. Section 3.0 provides a summary description of the specific methods used to predict noise from EELV activities.

1.0 NOISE DESCRIPTORS AND PREDICTION

EELV launch vehicles would generate two types of sound. One is engine noise, which is continuous sound. The other is sonic booms, which are transient, impulsive sounds. These are quantified in different ways.

Section 1.1 describes the quantities used to describe sound. Section 1.2 describes rocket noise and how it is modeled. Section 1.3 describes the modeling and presentation of sonic booms.

1.1 NOISE DESCRIPTORS

Measurement and perception of sound involves two basic physical characteristics: amplitude and frequency. Amplitude is a measure of the strength of the sound and is directly measured in terms of the pressure of a sound wave. Because sound pressure varies in time, various types of pressure averages are usually used. Frequency, commonly perceived as pitch, is the number of times per second the sound causes air molecules to oscillate. Frequency is measured in units of cycles per second, or Hertz (Hz).

Amplitude. The loudest sounds the human ear can comfortably hear have acoustic energy one trillion times the acoustic energy of sounds the ear can barely detect. Because of this vast range, attempts to represent sound amplitude by pressure are generally unwieldy. Sound is therefore usually represented on a logarithmic scale with a unit called the decibel (dB). Sound on the decibel scale is referred to as a sound level. The threshold of human hearing is approximately 0 dB, and the threshold of discomfort or pain is around 120 dB.

The difference in dB between two sounds represents the ratio of those two sounds. Because human senses tend to be proportional (i.e., detect whether one sound is twice as big as another) rather than absolute (i.e., detect whether one sound is a given number of pressure units bigger than another), the decibel scale correlates well with human response.

Frequency. The normal human ear can hear frequencies from about 20 Hz to about 15,000 or 20,000 Hz. It is most sensitive to sounds in the 1,000 to 4,000 Hz range. When measuring community response to noise, it is common to adjust the frequency content of the measured sound to correspond to the frequency sensitivity of the human ear. This adjustment is called A-weighting (American National Standards Institute, 1988). Sound levels that have been so adjusted are referred to as A-weighted sound levels. The amplitude of A-weighted sound levels is measured in dB. It is common for some noise analysts to denote the unit of A-weighted sounds by dBA or dB(A). As long as the use of A-weighting is understood, there is no difference between dB, dBA or dB(A). It is only important that the use of A-weighting be made clear. It is common to use the term A-weighted sound pressure level (AWSPL) to refer to A-weighted sounds.

For analysis of damage to structures by sound, it is common not to apply any frequency weighting. Such overall sound levels are measured in dB and are often referred to as overall sound pressure levels (OASPL or OSPL).

C-weighting (American National Standards Institute, 1988) is sometimes applied to sound. This is a frequency weighting that is flat over the range of human hearing (about 20 Hz to 20,000 Hz) and rolls off above and below that range. C-weighted sound levels are often used for analysis of high-amplitude impulsive noise, where adverse impact is influenced by rattle of buildings.

Time Averaging. Sound pressure of a continuous sound varies greatly with time, so it is customary to deal with sound levels that represent averages over time. Levels presented as instantaneous (i.e., as might be read from the dial of a sound level meter), are based on averages of sound energy over either 1/8 second (fast) or one second (slow). The formal definitions of fast and slow levels are somewhat complex, with details that are important to the makers and users of instrumentation. They may, however, be thought of as levels corresponding to the root-mean-square sound pressure measured over the 1/8-second or 1-second periods.

The most common uses of the fast or slow sound level in environmental analysis are in the discussion of the maximum sound level that occurs from the action, and in discussions of typical sound levels. Figure F-1 is a chart of sound levels from typical sounds.

Assessment of cumulative noise impact requires average levels over periods longer than just the fast or slow times. The sound exposure level (SEL) sums the total sound energy over a noise event. Mathematically, the mean square sound pressure is computed over the duration of the event, then multiplied by the duration in seconds, and the resultant product is turned into a sound level. SEL is sometimes described as the level which, occurring for one second, would have the same sound energy as the actual event.

Note that SEL is a composite metric that combines both the amplitude of a sound and its duration. It is a better measure of noise impact than the maximum sound level alone, since it accounts for duration. Long sounds are more intrusive than short sounds of equal level, and it has been well established that SEL provides a good measure of this effect.

SEL can be computed for A- or C-weighted levels, and the results denoted ASEL or CSEL. It can also be computed for unweighted (overall) sound levels, with a corresponding designation.

For longer periods of time, total sound is represented by the equivalent continuous sound pressure level (L_{eq}). L_{eq} is the average sound level over some time period (often an hour or a day, but any explicit time span can be specified), with the averaging being done on the same energy basis as used

Figure F-1. A-Weighted Sound Levels of Common Sounds for SEL. SEL and L_{eq} are closely related, differing according to (a) whether they are applied over a specific time period or over an event, and (b) whether the duration of the event is included or divided out.

Just as SEL has proven to be a good measure of the noise impact of a single event, L_{eq} has been established to be a good measure of the impact of a series of events during a given time period. Also, while L_{eq} is defined as an average, it is effectively a sum over that time period and is thus a measure of the cumulative impact of noise.

Noise tends to be more intrusive at night than during the day. This effect is accounted for by applying a 10-dB penalty to events that occur after 10 p.m. and before 7 a.m. If L_{eq} is computed over a 24-hour period with this nighttime penalty applied, the result is the day-night average sound level (L_{dn} or DNL). L_{dn} is the community noise metric recommended by the U.S. Environmental Protection Agency (U.S. Environmental Protection Agency, 1972) and has been adopted by most federal agencies (Federal Interagency Committee on Noise, 1992). It has been well established that L_{dn} correlates well with community response to noise (Schultz, 1978; Finegold et al., 1994).

The state of California quantifies noise by Community Noise Equivalent Level (CNEL). This metric is similar to L_{dn} except that a penalty of 5 dB is applied to sounds that occur in the evening, after 7:00 p.m. and before 10:00 p.m.

It was noted earlier that, for impulsive sounds, C-weighting is more appropriate than A-weighting. The day-night average sound level can be computed for C-weighted noise, and is denoted L_{Cdn} or CDNL. This procedure has been standardized, and impact interpretive criteria similar to those for L_{dn} have been developed (CHABA, 1981).

1.2 ROCKET NOISE

Rocket noise is generated primarily by the mixing of the high-speed rocket exhaust flow with the atmosphere. Noise is also generated by fuel and oxidizer burning in the combustion chamber, shock waves and turbulence within the exhaust flow, and sometimes, burning of excess fuel in the exhaust flow. The result is a high-amplitude continuous sound, directed generally behind the vehicle. Figure F-2 shows the typical pattern of noise behind a rocket engine. In this illustration, the exhaust flow is horizontal, directed toward the east (right). This corresponds to a horizontally mounted rocket (common in ground testing of engines) or a rocket on a launch pad where a deflector has turned the exhaust sideways. Noise is shown as contours of various decibel values. All points inside a given contour experience noise equal to or higher than that contour value. The pattern is fairly uniform in the forward direction (toward the left in this figure), has high-amplitude lobes at around 45 degrees from the flow direction (the angle of the lobes varies), and has a minimum directly in line with the exhaust.

When a rocket is launched, after a short time, it is above the ground, and the exhaust is clear of the ground and any deflectors. When the rocket is climbing vertically, the noise contours on the ground are circular. As the rocket continues to climb, it will pitch over in its launch azimuth. The contours will be distorted in this direction, sometimes becoming stretched and sometimes broadened, depending on details of the particular vehicle and launch. Figure F-3 shows typical noise contours for a launch toward the east. The trajectory is indicated, and the launch point is at the center of the innermost contours.

Figure F-2. Nominal Noise Contours for Horizontal Firing Rocket Engine

Figure F-3. Nominal Noise Contours for Ascent of a Launch Vehicle

In Figure F-2, as long as the rocket is on the ground the noise is constant, and the contours show what would be measured at any time while the engine is firing. For a launch, as in Figure F-3, noise is not constant. It is loudest shortly after launch, then diminishes as the rocket climbs. The noise is still considered to be continuous because it varies over periods of seconds or minutes. Contours of AWSPL or OSPL are drawn to represent the maximum levels that occur at each point during the entire launch. These levels may only occur for a few seconds and do not occur at the same time at each point, but are the most important (i.e., worst case) quantity for assessing launch noise impact.

In this assessment, contours (similar to Figure F-3) are presented for launch noise. Because contours are approximately circular, it is often adequate to summarize noise by giving the sound levels at a few distances from the launch site.

1.3 SONIC BOOMS

When launch vehicles reach supersonic speed, they generate sonic booms. Sonic booms are the shock waves resulting from the displacement of air in supersonic flight. They differ from other sounds in that they are impulsive and brief.

Figure F-4 is a sketch of sonic boom for the simple case of an aircraft in steady-level flight. The aircraft is flying to the left. The sonic boom consists of two shock waves: one generally associated with the front of the aircraft, and one with the rear. They are connected by a linear expansion. The pressure-time signature at the ground resembles the letter “N” and is referred to as an N-wave. It is described by the peak overpressure of each shock, and the time between the shocks. Usually the time between shocks does not affect impact, so sonic booms are most commonly described by their peak overpressures.

In Figure F-4, the sonic boom is generated continuously as the aircraft flies, and this illustration is from the perspective of moving with the aircraft. At a location on the ground, however, the boom exists briefly as the N-wave passes over that point. It is common to refer to the footprint of a steady-flight sonic boom as a “carpet”, consisting of a “carpet” of area on the ground that is swept out as the aircraft flies along its path. N-wave booms are often referred to as “carpet booms”.

Figure F-5 shows an aircraft sonic boom from a different perspective. The aircraft is flying to the right, and the cone to the left is a three-dimensional version of the shocks in Figure F-4. It is the boom as it exists at a given time. It is generated over a period of time, with the boom at the ground having been created at an earlier time. The sonic boom energy generated at a given time propagates forward of the aircraft, along a cone similar to the one projected to the right in Figure F-5. It reaches the ground in a forward-facing crescent, as indicated in the figure.

Sonic booms from launch vehicles differ from those sketched in Figures F-4 and F-5 in two ways. First, launch vehicles begin their flight vertically, then slowly pitch over toward the horizontal. Second, launch vehicles accelerate, so speed is continuously changing as they ascend. The cone angles shown in Figures F-4 and F-5 change with speed. Shock waves are generated only after the vehicle exceeds Mach 1, and reach the ground as sonic booms only after the vehicle has pitched over and reached a particular Mach number. Figure F-6 shows nominal sonic boom noise contours (not to scale) from a launch vehicle. The contour values represent pressure in pounds per square foot (psf), the unit most commonly used. The launch site is noted on the figure, and the launch

Figure F-4. Sonic Boom from an Aircraft in Level Flight

Figure F-5. Sonic Boom in Level Flight, Showing Shock Wave and Propagation of Boom Energy

Figure F-6. Nominal Sonic Boom Contours for Ascent of a Launch Vehicle direction is to the right. As with the noise contours shown in Figures F-2 and F-3, regions within each contour experience overpressures equal to or greater than that denoted for the contour. Also, the contours denote the peak pressure that occurs at each point over the course of the launch and does not represent noise at any one time. The sonic boom event at each position is brief, as noted in the preceding paragraph.

Because sonic boom is not generated until the vehicle becomes supersonic some time after launch, the launch site itself does not experience a sonic boom. The crescent shape of the contours reflects this “after launch” nature of sonic boom: the entire boom footprint is downtrack, and portions of the footprint to the side of the trajectory (up and down in the figure) are farther downtrack. This pattern is similar to the forward-facing crescent seen in the right half of Figure F-5. There is no boom to the left of the contours shown, and the boom diminishes rapidly farther downtrack, to the right of the contours.

The left edge of the contours shown in Figure F-6 is a special region. Because the vehicle is accelerating, sonic boom energy tends to be more concentrated than if it were in steady flight. The left edge is where the boom first reaches the ground, and the concentration is highest there. There is a narrow “focus boom” or “superboom” region, usually less than 100 yards where the sonic boom amplitude is highest. The boom signature is also distorted into what is referred to as a “U-wave”.

Figure F-7 shows time histories (pressure versus time) for N-wave carpet booms and U-wave focus booms. Each consists of a pair of shock waves connected by a linear expansion (N-wave) or a U-shaped curve (U-wave). Each type of boom is well described by its peak overpressure in pounds per square foot (psf), and its duration in milliseconds (msec). Duration tends to have a minor effect on impact, so the peak pressure is all that is normally required.

The 0.5-psf contour shown in Figure F-6, although not to scale, has a shape similar to an actual low-overpressure sonic boom contour. The two higher contours, 2.0 and 5.0 psf, are considerably distorted from typical actual contours. The crescent shape is correct, and their width across the trajectory (i.e., vertical height on this figure) relative to the 0.5-psf contour is approximately correct. Their width and position in the direction along the trajectory is greatly exaggerated. It is typical that the left edge of these higher contours would be very close to the left edge of the 0.5-psf contour, and would not appear as a distinct line when plotted to any reasonable scale. The right edge of these contours would also be much closer to the left than shown and would often not appear as distinct lines. The focus boom region is within the 0.5-psf contour.

For assessment of impact via L_{Cdn} as discussed in Section 1.1, the peak pressure is related in a simple way to CSEL, from which L_{Cdn} can be constructed. The peak pressure P (psf) is converted to the peak level (L_{pk}) dB by the relation:

$$L_{pk} = 127.6 + 20 \log_{10} P$$

CSEL is then given by Plotkin (1993):

$$\text{CSEL} = L_{pk} - 26 \qquad \text{(N-wave)}$$

$$\text{CSEL} = L_{pk} - 29 \qquad \text{(U-wave)}$$

Figure F-7. Focused U-Wave and Unfocused N-Wave Boom Signatures

Most sonic boom literature describes booms in terms of overpressure psf. This assessment adheres to that convention. The above relations give simple conversions to decibels should those units be of interest.

2.0 NOISE EFFECTS

2.1 ANNOYANCE

Studies of community annoyance from numerous types of environmental noise show that L_{dn} is the best measure of impact. Schultz (1978) showed a consistent relationship between L_{dn} and annoyance. This relationship, referred to as the "Schultz curve", has been reaffirmed and updated over the years (Fidell et al., 1991; Finegold et al., 1994). Figure F-8 shows the current version of the Schultz curve.

A limitation of the Schultz curve is that it is based on long-term exposure to noise. EELV launches will be relatively infrequent. Therefore, analysis in the current study examines individual noise levels rather than L_{dn} compared to the Schultz curve.

Some time ago, L_{dn} of 55 dB or less was identified as a threshold below which adverse impacts to noise are not expected (U.S. Environmental Protection Agency, 1972). It can be seen from Figure F-8 that this is a region where a small percentage of people is highly annoyed. L_{dn} of 65 dB is widely accepted as a level above which some adverse impact should be expected (Federal Interagency Committee on Noise, 1992), and it is seen from Figure F-8 that about 15 percent of people are highly annoyed at that level.

2.2 SPEECH INTERFERENCE

Conversational speech is in the 60- to 65-dB range, and interference with this can occur when noise enters or exceeds this range. Speech interference is one of the primary causes of annoyance. The Schultz curve incorporates the aggregate effect of speech interference on noise impact.

Because EELV launches would be infrequent, and noise would last for only a few minutes, speech interference is not expected to be a major issue.

2.3 SLEEP INTERFERENCE

Sleep interference is commonly believed to represent a significant noise impact. The 10-dB nighttime penalty in L_{dn} is based primarily on sleep interference. Recent studies, however, show that sleep interference is much less than had been previously believed (Pearsons et al., 1989; Ollerhead, 1992).

Traditional studies of sleep disturbance indicate that interference can occur at levels as low as 45 dB. Data indicates that at indoor SEL of 70 dB, about 20 percent of people will awaken (Federal Interagency Committee on Noise, 1992). Assuming a nominal outdoor-to-indoor noise reduction of 20 dB, these correspond to outdoor sound exposure levels of 65 dB and 90 dB, respectively. Note that the awakening threshold is comparable to the threshold of outdoor speech interference.

Figure F-8. Community Response to Noise

2.4 TASK INTERFERENCE

Due to startle effects, some task interference may occur from sonic booms. High levels of rocket noise may cause some task interference close to the launch sites. It is difficult to estimate degrees of task interference, since this is highly dependent on specific tasks. Startle from sonic booms is often stated as a concern, but there are no credible reported incidents of harm from sonic boom startle. Task interference from rocket noise is expected to occur at higher noise levels than speech interference.

2.5 HEARING LOSS

Federal Occupational Safety and Health Administration (OSHA) guidelines (Title 29 CFR 1910.95) specify maximum noise levels to which workers may be exposed on a regular basis without hearing protection. Pertinent limits are a maximum of 115 dBA for up to 15 minutes per day, and unweighted impulsive noise of up to 140 dB. Exceeding these levels on a daily basis over a working career is likely to lead to hearing impairment. These levels are conservative for evaluating potential adverse effects from occasional noise events.

2.6 HEALTH

Nonauditory effects of long-term noise exposure, where noise may act as a risk factor, have never been found at levels below federal guidelines established to protect against hearing loss. Most studies attempting to clarify such health effects found that noise exposure levels established for hearing protection will also protect against nonauditory health effects (von Gierke, 1990). There are some studies in the literature that claim adverse effects at lower levels, but these results have generally not been reproducible.

2.7 STRUCTURES

2.7.1 Launch Noise

Damage to buildings and structures from noise is generally caused by low-frequency sounds. The probability of structural damage claims has been found to be proportional to the intensity of the low-frequency sound. Damage claim experience (Guest and Sloane, 1972) suggests that one claim in 10,000 households is expected at a level of 103 dB, one in 1,000 households at 111 dB, and one in 100 households at 119 dB.

Figure F-9 shows criteria for damage to residential structures (Sutherland, 1968) and compares them to launch noise spectra that could occur a few kilometers from the launch pad. These data show that noise-induced damage to off-base property would be minimal.

2.7.2 Sonic Boom

Sonic booms are commonly associated with structural damage. Most damage claims are for brittle objects, such as glass and plaster. Table F-1 summarizes the threshold of damage that might be expected at various overpressures. There is a large degree of variability in damage experience, and much damage depends on the pre-existing condition of a structure. Breakage data for glass, for

Figure F-9. Criteria for Noise Damage to Residential Structures and Typical Off-Base Launch Noise Spectrum.

Table F-1. Possible Damage to Structures From Sonic Booms

Sonic Boom Overpressure Nominal (psf)	Type of Damage	Item Affected
0.5-2	Cracks in plaster	Fine; extension of existing; more in ceilings; over door frames; between some plaster boards.
	Cracks in glass	Rarely shattered; either partial or extension of existing.
	Damage to roof	Slippage of existing loose tiles/slates; sometimes new cracking of old slates at nail hole.
	Damage to outside walls	Existing cracks in stucco extended.
	Bric-a-brac	Those carefully balanced or on edges can fall; fine glass, e.g., large goblets, can fall and break.
	Other	Dust falls in chimneys.
2-4	Glass, plaster, roofs, ceilings	Failures show that would have been difficult to forecast in terms of their existing localized condition. Nominally in good condition.
4-10	Glass	Regular failures within a population of well-installed glass; industrial as well as domestic greenhouses.
	Plaster	Partial ceiling collapse of good plaster; complete collapse of very new, incompletely cured, or very old plaster.
	Roofs	High probability rate of failure in nominally good state, slurry-wash; some chance of failures in tiles on modern roofs; light roofs (bungalow) or large area can move bodily.
	Walls (out)	Old, free standing, in fairly good condition; can collapse.
	Walls (in)	Interior walls known to move at 10 psf.
Greater than 10	Glass	Some good glass will fail regularly to sonic booms from the same direction. Glass with existing faults could shatter and fly. Large window frames move.
	Plaster	Most plaster affected.
	Ceilings	Plaster boards displaced by nail popping.
	Roofs	Most slate/slurry roofs affected, some badly; large roofs having good tile can be affected; some roofs bodily displaced causing gable-end and wall-plate cracks; domestic chimneys dislodged if not in good condition.
	Walls	Interior walls can move even if carrying fittings such as hand basins or taps; secondary damage due to water leakage.
	Bric-a-brac	Some nominally secure items can fall; e.g., large pictures, especially if fixed to party walls.

Source: Haber and Nakaki, 1989

example, spans a range of two to three orders of magnitude at a given overpressure. While glass can suffer damage at low overpressures, as shown in Table F-1, laboratory tests of glass (White, 1972) have shown that properly installed window glass will not break at overpressures below 10 psf, even when subjected to repeated booms.

Most of the area exposed to sonic booms will be below 2 psf, where there is a small probability of damage. Boom amplitude will exceed this in limited areas associated with focusing, with maximum overpressures in the 6- to 8-psf range. Because of the limited area involved in a focal zone, adverse impact will depend on the relation of the focal zones to sensitive receptors.

2.8 WILDLIFE

The response to sonic booms or other sudden disturbances is similar among many species (Moller, 1978). Sudden and unfamiliar sounds usually act as an alarm and trigger a “fight or flight” startle reaction. This sudden panic response may cause wildlife to injure themselves or their young; however, this is usually the result of the noise in association with the appearance of something perceived by the animals as a pursuit threat, such as a low-flying aircraft. Launch noise is not expected to cause more than a temporary startle-response because the “pursuit” would not be present. Any loss or injury as a result of this startle response would be incidental and not a population-wide effect. Animals control their movements to minimize risk. Loss rates have varied greatly in the few documented cases of injury or loss: mammals and raptors appear to have little susceptibility to those losses; the most significant losses have been observed among waterfowl. Panic responses typically habituate quickly and completely with fewer than five exposures (Bowles, 1997).

During a Titan II launch from SLC-4 at Vandenberg AFB, all snowy plovers flushed and settled in a somewhat different flock configuration. One-half mile south of the Santa Ynez River, no discernible response occurred during launch. The snowy plovers stood from roost sites and walked one meter from original roosting position. The reaction exhibited resembled the response to a perceived predator threat, including a return to normal behavior when the perceived threat had passed (Read, 1996a,b).

The startling effect of a sonic boom can be stressful to an animal. This reaction to stress causes physiological changes in the neural and endocrine systems including increased blood pressure and higher levels of available glucose and corticosteroids in the bloodstream. Continued disturbances and prolonged exposure to severe stress may deplete nutrients available to the animal.

Both physiological and behavioral responses to sonic booms have been examined among California pinnipeds (Manci et al., 1988). The physiological study demonstrated recognizable short-lived changes in hearing sensitivity due to minimum sonic boom overpressures. Longer temporary hearing losses are likely to occur for exposures greater than those tested (Manci et al., 1988).

Behaviorally, harbor seals, California sea lions, northern fur seals, and Guadalupe fur seals at the Channel Islands will react to sonic booms of any intensity, and many will move rapidly into the water depending on the season and amplitude of the boom. However, any observed response is usually short in duration. Elephant seals will startle in response to sonic booms of low intensity, but they resume normal behavior within a few minutes of the disturbance (Manci et al., 1988).

A launch effect of 127.4 dB (108.1 dBA) caused 20 of 23 of the Purisima Point harbor seals to flee into the water, and only 3 returned after 2.5 hours. At Rocky Point, 20 of 74 harbor seals fled into the water during a 103.9-dB (80-dBA) launch event, returning after 30 minutes. Another launch (98.7 to 101.8 dBA) caused almost all Rocky Point harbor seals ashore to flee into the water, after which 75 percent returned within 90 minutes (Tetra Tech, Inc., 1997).

Harbor seals, California sea lions, northern fur seals, and Guadalupe fur seals at the Channel Islands will startle in response to sonic booms of any intensity, and many will move rapidly into the water depending on the season and amplitude of the boom. However, any observed response is usually short-lived. Elephant seals will startle in response to sonic booms of low intensity, but they resume normal behavior within a few minutes of the disturbance (Manci et al., 1988).

Manatees are relatively unresponsive to human-generated noise to the point that they are often suspected of being deaf to oncoming boats (although their hearing is actually similar to that of pinnipeds) (Bullock et al., 1980). Since manatees spend most of their time below the surface, and since they do not startle readily, no effect of aircraft or launch vehicle overflights on manatees would be expected (Bowles et al., 1991).

The effect of launch noises on cetaceans appears to be somewhat attenuated by the air/water interface. The cetacean fauna in the area have been subjected to sonic booms from military aircraft for many years without apparent adverse effects (Tetra Tech, Inc., 1997).

Raptor response to sonic boom while nesting was investigated through the use of simulated booms in natural conditions. Response to sonic boom was fairly minimal (Ellis et al., 1991). The sonic booms generated for response testing were equivalent to impulse noises generated by supersonic jets in the medium- to high-altitude range (2,000-3,000 m). There was a total of seven raptor species tested including 84 individuals in various life stages. Of the individuals observed during sonic booms, 65 responses were insignificant. Adult response to the sonic boom usually resulted in flushing from the nest, although incubating or brooding adults never left the nesting area. Reactions among species did have some variation. The reproductive rates for the tested sites were at or above normal for both years of testing. Heart rate response to sonic booms were measured using captive peregrine falcons. Heart rates after sonic booms were at or below a heart rate level of a falcon returning from flight (Ellis et al., 1991). In a different study on adult peregrine falcons, the startle response was found to cause egg breakage of already thin eggshells (residual dichlorodiphenyltrichloroethane (DDT) effects) or cause young close to fledgling age to fledge prematurely, thus placing them at a particularly high risk of mortality (Read, 1996a). Peregrine falcons at the early nesting phase are not adversely impacted by Titan IV launches because the chicks are expected to crouch safely down in their nests rather than move toward the edge of the ledge (Read, 1996a).

A huge sooty tern nesting failure that occurred in the southern Florida Dry Tortugas colony in 1969 may have been a result of sonic booms that occurred on a daily basis (Austin et al., 1970). Birds had been observed to react to sonic booms in previous seasons with a panic flight, circling over the island momentarily and then usually settling down on their eggs again. Upon review, the nesting failure was attributed to be most likely due to the interruption of the incubation period and from nest abandonment.

3.0 NOISE MODELING

3.1 LAUNCH NOISE

On-pad and in-flight rocket noise was computed using the RNOISE model (Plotkin et al., 1997). Rocket noise prediction via this model consists of the following elements:

1. The total sound power output, spectral content and directivity is based on the in-flight noise model of Sutherland (1993). Noise emission is a function of thrust, nozzle exit gas velocity, nozzle exit diameter, and exhaust gas properties.

   Propagation from the vehicle to the ground accounts for Doppler shift, absorption of sound by the atmosphere (American National Standards Institute, 1978), inverse square law spreading, and attenuation of sound by the ground (Chien and Soroka, 1980). A semi-hard ground surface (1,000 mks rayls) was assumed.

2. One-third spectral levels were computed at the ground, for every flight trajectory point, on a grid of 3,721 points. ASEL and maximum A-weighted and overall sound levels were then derived from the results at each grid point.

The computed noise levels were then depicted as contours of equal level.

3.2 SONIC BOOM

Sonic boom was computed using the U.S. Air Force's PCBoom3 software (Plotkin, 1996). This is a full ray tracing model. Details of sonic boom theory are presented by Plotkin (1989) and Maglieri and Plotkin (1991). The specific approach to EELV sonic boom modeling included the following elements:

1. Trajectories provided by the vehicle manufacturers were converted into PCBoom3 TRJ format using PCBoom3's TRAJ2TRJ utility. This utility generated required higher derivatives, as well as converting file formats.

2. Vehicle F-functions were calculated using the method of Carlson (1978). Area distributions were obtained from vehicle drawings. The shape factors computed were used to obtain nominal N-wave F-functions.

3. The F-function associated with the plume was obtained using a combination of the Universal Plume Model (Jarvinen and Hill, 1970) and Tiegerman's (1975) hypersonic boom theory.

4. Ray tracing and signature evolution were computed by integration of the eiconal and Thomas's (1972) wave parameter method.

5. Focal zones were detected from the ray geometry, and focus signatures computed by applying Gill and Seebass's (1975) numerical solution.

The resultant sonic boom calculations were depicted as contours of constant overpressure (psf).

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Table G-1. Plant and Animal Species Potentially Occurring in the Vicinity of Cape Canaveral AS
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Common Name	Scientific Name
Plants	
Water Plaintain Family	**Alismataceae**
Arrowheads	*Sagittaria* spp.
Sumac or Cashew Family	**Anacardiaceae**
Brazilian pepper	*Schinus terebinthifolius*
Poison ivy	*Toxicodendron radicans*
Custard Apple Family	**Annonaceae**
Pond apple	*Annona glabra*
Palm Family	**Arecaceae**
Palmetto	*Sabal* spp.
Cabbage palmetto	*Sabal palmetto*
Saw Palmetto	*Serenoa repens*
Milkweed Family	**Asclepiadaceae**
Curtiss' milkweed	*Asclepias curtissii*
Sunflower Family	**Asteraceae**
Groundsel tree	*Baccharis halmifolia*
Sea oxeye daisy	*Borrichia frutescens, B. arborescens*
Beach elder	*Iva imbricata*
Camphorweed	*Pluchea purpurascens*
Cactus Family	**Cactaceae**
Prickly pear	*Opuntia* spp.
Honeysuckle Family	**Capriofoliaceae**
Twinberry	*Locinera involucrata*
Rock Rose Family	**Cistaceae**
Nodding pinweed	*Lechea cernua*
Combretum Family	**Combretaceae**
Buttonwood	*Conocarpus erecta*
Morning Glory Family	**Convolvulaceae**
Railroad vine	*Ipomoea pes-caprae*
Cypress Family	**Cupressaceae**
Red cedar	*Juniperus virginiana*
Sedge Family	**Cyperaceae**
Sedges	*Carex* spp.
Crowberry Family	**Empetraceae**
Rosemary	*Ceratiola ericoides*
Spurge Family	**Euphorbiaceae**
Beach croton	*Croton* spp.
Oak Family	**Fagaceae**
Chapman's oak	*Quercus chapmanii*
Sand live oak	*Quercus geminata*

Table G-1. Plant and Animal Species Potentially Occurring in the Vicinity of Cape Canaveral AS
Page 2 of 5

Common Name	Scientific Name
Plants (Continued)	
Myrtle oak	*Quercus myrtifolia*
Live oak	*Quercus virginiana*
Gentian Family	**Gentianaceae**
Sabatia	*Sabatia* spp.
Laurel Family	**Lauraceae**
Red bay	*Persea borbonia*
Lily Family	**Liliaceae**
Catbrier	*Smilax* spp.
Mulberry Family	**Moraceae**
Strangler fig	*Ficus aurea*
Red mulberry	*Morus rubra*
Wax Myrtle Family	**Myricaceae**
Wax myrtle	*Myrica cerifera*
Myrsine Family	**Myrsinaceae**
Myrsine	*Myrsine quianensis*
Adder's Tongue Family	**Ophioglassaceae**
Hand fern	*Ophioglossum palmatum*
Pine Family	**Pinaceae**
Sand pine	*Pinus clausa*
Grass Family	**Poaceae**
Saltgrass	*Distichlis spicata*
Muhly grass	*Muhlenbergia* spp.
Cuban shoal grass	*Halodule wrightii*
Beach cordgrass	*Spartina* spp.
Sea oats	*Uniola paniculata*
Buckwheat Family	**Polygonaceae**
Sea grapes	*Coccoloba uvifera*
Buckthorn Family	**Rhamnaceae**
Buckthorn	*Rhamnus caroliniana*
Tough buckthorn	*Rhamnus* spp.
Rose Family	**Rosaceae**
Carolina Laurelcherry	*Prunus caroliniana*
Rue Family	**Rutaceae**
Hercules' club	*Zanthoxylem clava-herculis*
Willow Family	**Salicaceae**
Willows	*Salix* spp.
Soapberry Family	**Sapindaceae**
Varnish leaf	*Dodoneae viscosa*
Sapodilla Family	**Sapotaceae**
Satin leaf	*Chrysophyllum oliviforme*

Table G-1. Plant and Animal Species Potentially Occurring in the Vicinity of Cape Canaveral AS
Page 3 of 5

Common Name	Scientific Name
Plants (Continued)	
Bald Cypress Family	**Taxodiaceae**
Cypress tree	*Taxodium* spp.
Cattail Family	**Typhaceae**
Cattail	*Typha* spp.
Elm Family	**Ulmaceae**
Hackberry	*Celtis* spp.
American elm	*Ulmas americana*
Vervain Family	**Verbinaceae**
Black mangrove	*Avicennia germinans*
Mangrove	*Avicennia, Laguncularia, Rhizophora* spp.
Coastal vervain	*Glandulareia maritima*
White mangrove	*Laguncularia racemosa*
Grape Family	**Vitaceae**
Virginia creeper	*Parthenocissus quinquefolia*
Muscadine grape	*Vitis rotundifolia*
Animals	
Mammals	
Feral pig (swine)	*Sus* spp.
Sei whale	*Baeaenoptera borealis*
Finback whale	*Balaenoptera physalus*
Armadillo	*Dasypus novemcinctus*
Northern right whale	*Eubalaena glacialis*
Domestic cat	*Felis domesticus*
Bobcat	*Lynx rufus*
Humpback whale	*Megaptera novaeangliae*
Long-tailed weasel	*Mustela frenata*
White-tailed deer	*Odocoileus virginianus*
Round-tailed muskrat	*Ondatra zibethicus*
Southeastern beach mouse	*Peromyscus polionotus niveiventris*
Sperm whale	*Physeter catodon*
Florida mouse	*Podomys floridanus*
Raccoon	*Procyon lotor*
Rats	*Rattus* spp.
Spotted dolphin	*Stenelle dubia*
Manatee	*Trichechus manatus*
Bottlenose dolphin	*Tursiops truncatus*

Table G-1. Plant and Animal Species Potentially Occurring in the Vicinity of Cape Canaveral AS
Page 4 of 5

Common Name	Scientific Name
Birds	
Sharp-shinned hawk	*Accipiter striatus*
Spotted sandpiper	*Actitis macularia*
Roseate spoonbill	*Ajaia ajaja*
Florida scrub jay	*Aphelocoma coerulescens coerulescens*
Great blue heron	*Ardea herodias*
Ruddy turnstone	*Arenaria interpres*
Red-tailed hawk	*Buteo jamaicensis*
Northern cardinal	*Cardinalis cardinalis*
Turkey vulture	*Cathartes aura*
Willet	*Catotrophorus semipalmatus*
Piping plover	*Charadrius melodus*
Common ground dove	*Columbina passerina*
Fish crow	*Corvus ossifragus*
Blue jay	*Cyanocitta cristata*
Black-throated blue warbler	*Dendroica caerulescens*
Blackpoll warbler	*Dendroica striata*
Gray catbird	*Dumetella carolinenses*
Little blue heron	*Egretta caerulea*
Peregrine falcon	*Falco perigrinus*
Southeastern American kestrel	*Falco sparverius paulus*
Bald eagle	*Haliaetus leucocephalus*
Black-necked stilt	*Himantopus mexicanus*
Barn swallow	*Hirundo rustica*
Red-bellied woodpecker	*Melanerpes carolinus*
Northern mockingbird	*Mimus polyglottus*
Black-and-white warbler	*Mniotilta varia*
Wood stork	*Mycteria americana*
Osprey	*Pandion haliaetus*
Downy woodpecker	*Pecoides pubescens*
Brown pelican	*Pelicanus occidentalis*
Rufous-sided towhee	*Pipilo erythrophthalmus*
Common grackel	*Quiscalus mexicanus*
Ovenbird	*Seirus aurocapillus*
American redstart	*Setophaga ruticilla*
Least tern	*Sterna antillarum*
Caspian tern	*Sterna caspia*
House wren	*Troglodytes aedon*
Eastern kingbird	*Tyrannus tyrannus*
Blue-winged warbler	*Vermivora pinus*
Yellow-throated vireo	*Vireo flavifrons*
Red-eyed vireo	*Vireo olivaceus*
Mourning dove	*Zenaida macroura*

Table G-1. Plant and Animal Species Potentially Occurring in the Vicinity of Cape Canaveral AS
Page 5 of 5

Common Name	Scientific Name
Amphibians and Reptiles	
American alligator	*Alligator mississippiensis*
Green anole	*Anolis carolinensis*
Florida softshell	*Apalone* spp.
Atlantic loggerhead sea turtle	*Caretta caretta*
Green sea turtle	*Chelonia mydas*
Six-lined racerunner	*Cnemidophorus sexlineatus*
Racer	*Coluber constrictor*
Leatherback sea turtle	*Dermochelys coriacea*
Southern ringneck snake	*Diadophis punctatus*
Eastern indigo snake	*Drymarchon corais couperi*
Hawksbill sea turtle	*Eretmochelys imbricata imbricata*
Broadhead skink	*Eumeces laticeps*
Eastern narrow-mouthed toad	*Gastroophryne carolinensis*
Gopher tortoise	*Gopherus polyphemus*
Green treefrog	*Hyla cinerea*
Squirrel frog	*Hyla squirella*
Atlantic (Kemp's) Ridley sea turtle	*Lepidochelys kempi*
Eastern coachwhip	*Masticophis flagellum*
Mangrove salt marsh snake	*Nerodia clarkii compressicauda*
Gopher frog	*Rana capito*
Southern leopard frog	*Rana utricularia*
Spade-foot toad	*Scaphiopus holbrookii holbrookii*
Florida box turtle	*Terrapene carolina*
Fish	
Topminnow	*Fundulus lineolatus, or F. chrysotus*
Killfish	*Cyprinodontidae*
Garfish	*Lepisosteus* spp.
Bluegill	*Lepomis macrochirus*
Largemouth bass	*Micropterus salmoides*
Sailfin molly	*Poecilia latipinna*

Source: Florida Natural Areas Inventory, 1996b; National Aeronautics and Space Administration, 1995c, 1996.

Table G-2. Plant and Animal Species Potentially Occurring in the Vicinity of Vandenberg AFB
Page 1 of 7

Common name	Scientific name
Plants	
Fig-Marigold Family	**Aizoaceae**
Hottentot fig	*Carpobrotus eludis*
Sumac or Cashew Family	**Anacardiaceae**
Poison oak	*Toxicodendron diversilobilum*
Sunflower Family	**Asteraceae**
California sagebrush	*Artemisia californica*
Coyote brush	*Baccharis pilularis*
La Graciosa thistle	*Cirsium loncholepis*
Surf thistle	*Cirsium rhothophylum*
Mock heather	*Ericameria ericoides*
Goldenbush	*Isocoma menziesii*
Deer Fern Family	**Blechnaceae**
Beach layia	*Layia carnosa*
Borage Family	**Boraginaceae**
Large-flowered fiddleneck	*Amsinckia* spp.
Mustard Family	**Brassicaceae**
Black mustard	*Brassica nigra*
Beach spectaclepod	*Dithyrea maritima*
Gambel’s watercress	*Rorippa gambelli*
Honeysuckle Family	**Caprifoliaceae**
Twinberry	*Lonicera involucrata*
Pink Family	**Caryophyllaceae**
Marsh sandwort	*Arenaria paludicola*
Goosefoot Family	**Chenopodiaceae**
California goosefoot	*Chenopodium californicum*
Cypress Family	**Cupressaceae**
Monterey cypress	*Cupressus macrocarpa*
Sedge Family	**Cyperaceae**
Bullrushes	*Scirpus* spp.
Tule	*Scirpus validus*
Heath Family	**Ericacae**
Purisma manzanita	*Arctostaphylos purissima*
Sand mesa manzanita	*Arctostaphylos rudis*
Shagbark manzanita	*Arctostaphylos* spp.
Salal	*Gaultheria shallon*
Huckleberry	*Vaccinium ovatum*
Legume Family	**Fabaceae**
Locoweed	*Astragalus* spp.
Deerweed	*Lotus scoparius*
Lupine	*Lupinus* spp.

Table G-2. Plant and Animal Species Potentially Occurring in the Vicinity of Vandenberg AFB
Page 2 of 7

Common name	Scientific name
Plants (Continued)	
Tomcat clover	*Trifolium wildenovii*
Vetch	*Vicia* spp.
Oak Family	**Fagaceae**
Santa Cruz Island oak	*Quercus parvula*
Geranium Family	**Geraniaceae**
Filaree	*Erodium brachycarpum*
Waterleaf Family	**Hydrophyllaceae**
Lompoc yerba santa	*Eriodictyon capitatum*
Iris Family	**Iridaceae**
Blue-eyed grass	*Sisrinchium bellum*
Arrow Grass Family	**Juncaginaceae**
Crisp Monardella	*Monardella crispa*
San Luis Obispo monardella	*Monardella frutescens*
Myrtle Family	**Myrtaceae**
Eucalyptus	*Eucalyptus*
Blue eucalyptus	*Eucalyptus globulus*
Grass Family	**Poaceae**
Wild oats	*Avena fatua*
Brome	*Bromus* spp.
Veldt grass	*Ehrharta calycina*
Fescue	*Festuca arundinacea*
Giant wild rye	*Leymus condensatus*
Needle-grass	*Nassella carnua*
Buttercup Family	**Ranunculaceae**
Blochman's delphinium	*Delphinium parryi*
Dune delphinium	*Delphinium* spp.
Buckthorn Family	**Rhamnaceae**
Coast ceanothus	*Ceanothus* spp.
Santa Barbara ceanothus	*Ceanothus* spp.
Rose Family	**Rosaceae**
Chamise	*Adenostoma fasciculatum*
Kellogg's horkelia	*Horkelia* spp.
Blackberry	*Robus ursinas*
Willow Family	**Salicaceae**
Arroyo willow	*Salix lasiolepis*
Figwort Family	**Scrophulariaceae**
Owl's clover	*Castilleja attenuata, C. exserta, C. densiflora*
Seaside's bird's beak	*Cordylanthus rigidus* spp. *littoralis*
Lompoc bush monkeyflower	*Mimulus aurantiacus*
Black flowered figfort	*Scrophularia atrata*
Cattail Family	**Typhaceae**
Cattails	*Typha* spp.

Table G-2. Plant and Animal Species Potentially Occurring in the Vicinity of Vandenberg AFB
Page 3 of 7

Common name	Scientific name
Plants (Continued)	
Nettle Family	**Urticaceae**
Stinging nettle	*Uritica dioica*
Creek nettle	*Uritica holoserica*
Animals	
Mammals	
Guadalupe fur seal	*Arctocephalus townsendi*
Sei whale	*Baeaenoptera borealis*
Right whale	*Balaena glacialis*
Blue whale	*Balaenoptera musculus*
Finback whale	*Balaenoptera physalus*
Northern fur seal	*Callorhinus ursinus*
Coyote	*Canis latrans*
California ground squirrel	*Citellus variegatus*
Virginia opossum	*Didelphis virginiana*
Heerman's kangaroo rat	*Dipodomys heermanni*
Sea otter	*Enhydra lutris*
Southern sea otter	*Enhydra lutris nereis*
Grey whale	*Eschrichtius gibbosus*
Stellar sea lion	*Eumetopias jubatus*
Mountain lion	*Felis concolor*
Jackrabbit	*Lepus californicus*
Bobcat	*Lynx rufus*
Humpback whale	*Megaptera novaeangliae*
Striped skunk	*Mephitis mephitis*
Elephant seals	*Mirounga agustirostris*
Northern elephant seal	*Mirounga angustirostris*
Long-tailed weasel	*Mustela frenata*
Dusky-footed woodrat	*Neotoma fuscipes*
Desert woodrat	*Neotoma lepida*
Mule deer	*Odocoileus hemionus*
California pocket mouse	*Perognathus californicus*
California mouse	*Peromyscus eremicus*
Harbor seal	*Phoca vitulina*
Sperm whale	*Physeter catadon*
Raccoon	*Procyon lotor*
Ornate shrew	*Soex ornatus*
Trowbridge shrew	*Sorex trowbridgei*
Feral pig	*Sus scrofa*
Desert cottontail	*Sylvilagus auduboni*
Brush rabbit	*Sylvilagus bachmani*

Table G-2. Plant and Animal Species Potentially Occurring in the Vicinity of Vandenberg AFB
Page 4 of 7

Common name	Scientific name
Mammals (Continued)	
Badger	*Taxidea taxis*
Botta's pocket gopher	*Thommomys bottae*
California sea lion	*Zalophus californianus*
Birds	
Cooper's hawk	*Accipiter cooperii*
Southern California Rufous crowned sparrow	*Aimophila ruficeps*
Scrub jay	*Alphelocoma coerulescens*
Grasshopper sparrow	*Ammodramus savannarum*
Bell's sage sparrow	*Amphispiza belli*
Black-chinned hummingbird	*Archilochus alexandri*
Short-eared owl	*Asio flammeus*
Long-eared owl	*Asio otis*
Brant	*Branta bernicla*
Great-horned owl	*Bubo virginianus*
Red-tailed hawk	*Buteo jamaicensis*
Red-shouldered hawk	*Buteo lineatus*
Ferruginous hawk	*Buteo regalis*
California quail	*Callipepla gambelii*
Costa's hummingbird	*Calypte costae*
Pine siskin	*Carduelis pinus*
House finches	*Carpodacus mexicanus*
Swainson's thrush	*Catharus guttatus*
Hermit thrush	*Catharus guttatus*
Pigeon guillemot	*Cepphus columba*
Wrentit	*Chamaea fasciata*
Western snowy plover	*Charadrius alexandrinus nivosus*
Northern harrier	*Circus cyaneus*
Anna's hummingbird	*Clypte anna*
Western yellow-billed cuckoo	*Coccyzus americanus occidentalis*
Western wood peewee	*Contopus sordidulus*
Yellow-rumped warbler	*Dendroica coronata*
White-tailed kite	*Elanus leucurus*
Southwestern willow flycatcher	*Empidonax traillii extimus*
California horned lark	*Eremophila alpestris*
Merlin	*Falco columbarius*
Prairie falcon	*Falco mexicanus*
American peregrine falcon	*Falco peregrinus anatum*
American kestrel	*Falco sparverius*
Arctic loon	*Gavia arctica*
Loon	*Gavia immer*

Table G-2. Plant and Animal Species Potentially Occurring in the Vicinity of Vandenberg AFB
Page 5 of 7

Common name	Scientific name
Birds (Continued)	
Roadrunner	*Geococyx californianus*
Common yellowthroat	*Geothlypis trichas*
Southern bald eagle	*Haliaeetus leucocephalus*
Oriole	*Icterus* spp.
Loggerhead shrike	*Lanius ludovicianus*
Western gull	*Larus occidentalis*
Bonaparte's gull	*Larus philadelphia*
Gulls	*Larus* spp.
California black rail	*Laterallus jamaicensus coturniculus*
Song Sparrow	*Melospiza melodia*
Brown-headed cowbird	*Molothrus ater*
Long-billed curlew	*Numenius americanus*
Ashy storm-petrel	*Oceanodroma homochroa*
Leach's storm-petrel	*Oceanodroma luecorhoa*
Savannah sparrow	*Passerculus sandwichensis*
Belding's savannah sparrow	*Passerculus sandwichensis beldingi*
California brown pelican	*Pelacanus occidentalis californicus*
Brown Pelican	*Pelecanus occidentalis*
Double-crested	*Phalacrocorax auritus*
Pelagic cormorant	*Phalacrocorax pelagicus*
Brandt's cormorant	*Phalacrocorax penicillatus*
Red-necked phalarope	*Phalaropas lobatus*
Red phalarope	*Phalaropus fulicaria*
Black headed grosbeak	*Pheucticus melanocephalus*
Nutall's woodpecker	*Picoides nuttallii*
Downy woodpecker	*Picoides pubescens*
Hairy woodpecker	*Picoides villosus*
California towhee	*Pipilo crissalis*
Spotted towhee	*Pipilo erythrophthalmus*
Cassin's auklet	*Ptychoramphus aleuticus*
Ruby-crowned kinglet	*Regalus calendula*
Kinglet	*Regulus* spp.
Black phoebe	*Sayornis nigricans*
Burrowing owl	*Speotyto cunicularia*
California least	*Sterna antillarum browni*
Elegant tern	*Sterna elegans*
Western meadowlarks	*Sturnella neglecta*
European starling	*Sturnus vulgaris*
Tree swallow	*Tachycineta bicolor*
Bewick's wren	*Thryomanes bewickii*
California thrasher	*Toxostoma redivivum*
American robin	*Turdus migratorius*

Table G-2. Plant and Animal Species Potentially Occurring in the Vicinity of Vandenberg AFB
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Common name	Scientific name
Birds (Continued)	
Barn owl	*Tyto alba*
Common murre	*Uria aalge*
Least Bell's vireo	*Vireo bellii pusillus*
Warbling vireo	*Vireo gilvus*
Hutton's Vireo	*Vireo huttoni*
Wilson's warbler	*Wislonia pusilla*
White-crowned sparrow	*Zonotrichea leucophrys*
Amphibians and Reptiles	
California tiger salamander	*Ambystoma californiense*
Blackbelly slender salamander	*Batrachoseps nigriventris*
Western toad	*Bufo boreas*
Loggerhead sea turtle	*Caretta caretta*
Green sea turtle	*Chelonia mydas*
Southwestern pond turtle	*Clemmys marmorata*
Leatherback sea turtle	*Dermochelys coriacea*
Ensatina	*Ensatina eschscholtzii*
Western skink	*Eumeces skiltonianus*
Southern alligator lizard	*Gerrhonotus multicarinatus*
Pacific treefrog	*Hyla regilla*
Common kingsnake	*Lampropeltis getula*
Pacific Ridley sea turtle	*Lepidochelys olivacea*
Gopher snake	*Pituophis melanoleucus*
Pacific chorus frog	*Psuedacris regilla*
California red-legged frog	*Rana aurora draytonii*
Bullfrog	*Rana catesbeina*
Western fence lizard	*Sceloporus occidentalis*
Two-striped garter snake	*Thamnophis hamondii*
Common garter snake	*Thamnophis sirtalis*
Southern Pacific rattlesnake	*Crotalus viridis helleri*
Fish	
Topsmelt	*Atherinops affinis*
Pacific herring	*Clupea harengus*
Tidewater goby	*Eucyclogobius newberryi*
Mosquito fish	*Gambusia affinis*
Threespine stickleback	*Gasterosteus aculeatus microcephalus*
Unarmored threespine stickleback	*Gasterostreus aculeatus williamsonii*
Arroyo chub	*Gila orcutti*
Walleye surfperch	*Hyperprosopon argenteum*
Bluegill sunfish	*Lepomis macrochirus*

Table G-2. Plant and Animal Species Potentially Occurring in the Vicinity of Vandenberg AFB
Page 7 of 7

Common name	Scientific name
Fish (Continued)	
Bass	*Micropteras* spp.
Fathead minnow	*Pimephales promelas*
Starry flounder	*Platicthys stellatus*
Pile surfperch	R. *vacca*
Steelhead trout	*Oncorhynchus mykiss irideus*
Invertebrates	
Abalone	
Polychaete (marine) worms	*Auxiothella rubrocincta, Lumbrineris zonata*
Burrowing shrimp	*Callianasa californiensis*
Snail	*Gastropoda* spp.
Marine snail	*Mitrella carinata*
Seastar	*Patiria miniata*
Stonefly	*Plecoptera* spp.
Clam	*Tellina modesta*
Caddisfly	*Trichoptera* spp.

Source: Christopher, 1996a, 1996b; Holmgren and Collins, 1995; U.S. Air Force, 1978, 1989a, 1994c; Versar, 1991.

APPENDIX H

SUMMARY OF REQUEST FOR LETTER OF AUTHORIZATION FOR THE INCIDENTAL TAKE OF MARINE MAMMALS FOR PROGRAMMATIC OPERATIONS AT VANDENBERG AIR FORCE BASE, CALIFORNIA

Introduction

Vandenberg Air Force Base (AFB) submitted a request on July 11, 1997, to the National Marine Fisheries Service (NMFS) for a 5-year Letter of Authorization for the Incidental Take of Marine Mammals for Programmatic Operations on base. The purpose of the request is to eliminate the need to obtain 1-year permits for each programmatic operation and to receive instead a 5-year incidental take permit under Section 101(a)(5)(A) of the Marine Mammal Protection Act for all programmatic operations on Vandenberg AFB. The Air Force will be coordinating with the NMFS to determine whether the proposed EELV activities would be included under the conditions of such a permit. In support of this request, an Environmental Assessment was prepared by Vandenberg AFB to address potential noise impacts from actions proposed under the permit. The environmental assessment includes: coastal habitat of Vandenberg AFB, adjacent coastal waters, the northern Channel Islands, and the marine mammals that utilize these areas.

Included Activities

The application document addresses noise-related impacts from the following operations on Vandenberg AFB:

- The launch of Lockheed Martin Launch Vehicles from Space Launch Complex 6 (SLC-6)
- The launch of McDonnell Douglas Aerospace Delta II rockets from SLC-2W
- The launches of Titan II and Titan IV rockets from SLC-4
- The launch of Taurus rockets from Launch Support Complex 576-E
- Flight test operations that maintain a 1,000-foot standoff distance around pinniped colonies on pre-approved routes
- The helicopter operations of the 76th Rescue Flight (Helicopter Flight) for pad security, range safety/security, and aerial photography; which maintain a 1,000-foot standoff distance around pinniped colonies.

The Letter of Authorization for the Incidental Take of Marine Mammals sets limitations on the activities of the launch programs, including those listed above. The upper-limit activity level comprises approximately 10 ballistic and 20 space launches per year (a maximum of 100 space launches throughout the course of the permit), for a maximum of 30 launches per year.

Affected Marine Mammal Species

Marine mammals that could be affected by the programmatic activities on Vandenberg AFB include 6 species of pinnipeds (i.e., seals and sea lions) and 29 species of cetaceans (i.e., whales and dolphins).

The seals and sea lions in the area use the coastal habitat on Vandenberg AFB, the Channel Islands, and the surrounding waters for resting or hauling out and breeding. Pinniped species common to the area include California sea lions (*Zalophus californianus californianus*), Pacific harbor seals (*Phoca vitulina*), northern elephant seals (*Mirounga angustirostris*) and northern fur seals

(*Callorhinus ursinus*). All four species are known to breed in rookeries on the Channel Islands, in highest density at San Miguel Island. Guadalupe fur seals (*Arctocephalus townsendi*) and Stellar sea lions (*Eumetopias jubatas*) are found in the Santa Barbara Channel and at haul-out sites but are not known to breed in the area. Pinnipeds are most prevalent around the Channel Islands during the molting and breeding seasons.

Haul-out sites on base include Purisima Point and Rocky Point, used primarily by harbor seals, and Point Sal, which is used essentially by California sea lions, although northern elephant seals, California sea lions, and harbor seals can be seen along any area of the Vandenberg AFB coastline.

Cetaceans including toothed whales, dolphins, and baleen whales use the waters off the coast of California and near the Channel Islands as migration routes. Cetaceans are most often found to use waters at depths between 600 and 6,000 feet over the continental slope. Dolphins, killer whales (*Orcinus orca*), and some species of porpoise are common off the coast of Vandenberg AFB and the Channel Islands year-round.

Noise Impacts

Noise is generally defined as undesirable sound that affects and may interfere with wildlife and human normal activity and that diminishes the quality of the environment. Airborne noise measurements are often expressed as broadband A-weighted sound levels, expressed in dBA. The A-weighting scale approximates the hearing sensitivity of humans at low sound levels. The C-weighted scale is useful for sonic boom analysis because it emphasizes the lower frequencies. However, harbor seals are known to respond to a higher range of frequencies than humans.

Flight test operations will not reach supersonic speeds and thus will not create sonic booms, although many high-performance jets are extremely noisy, especially when using the afterburners. Launches, however, will include sonic boom. Generally, four types of noise are associated with the operation of launch vehicles. They are:

- Combustion noise from the launch vehicle chambers
- Jet noise from the interaction of the exhaust jet and the atmosphere
- Combustion noise from the post-burning of combustion products
- Sonic booms.

The period of maximum noise production during a launch will be less than 1 minute. Brief periods of engine noise from overflights, launches, and helicopters during pre-launch surveillance will also occur. Although of short duration, this noise may be sufficient to create a startle response in animals.

Generally, there has been little research on noise impacts on pinnipeds. Impacts may include auditory interference by masking average hearing capabilities, behavioral disruption, causing pinnipeds to stop their immediate behavior, and possible long-term effects that include temporary and permanent threshold shift in hearing.

Sonic boom from a launch can potentially impact pinniped and cetacean populations. Sonic booms are impulse noises with sharp initial peaks of sound pressure. The Titan IV rocket has the greatest potential to impact marine mammals. Cetaceans may also exhibit a startle response to launch noise. There is some indication that refraction from water may attenuate noise levels.

Habitat Impacts

The habitat of these animals is not expected to be impacted. No loss of critical or preferred habitat is expected due to ongoing operations at Vandenberg AFB. Any impacts to the population sizes of marine mammals due to habitat loss is not expected.

Mitigation and Monitoring

Mitigation measures for both flight tests and helicopter flight operations will be both spatial and temporal. A continual 1,000-foot standoff distance will be maintained around rookeries on base at Point Sal, Purisima Point, and Rocky Point. The only exceptions to this standoff distance would be emergency response or real-time security incidents. When feasible, launch windows will be scheduled outside of the pupping season and at night.

Monitoring to record any impacts due to launches will be performed at one of the on-base rookeries closest to the launch site. It will begin 72 hours prior to launch and will continue 48 hours after the launch. If a sonic boom could impact areas on the northern Channel Islands, those areas will be monitored. Monitoring results will be submitted in report form to the NMFS. If the monitoring shows mortalities or decreased reproductive levels during pupping season, the Air Force and NMFS will develop mitigation measures at that time.

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APPENDIX I
DESCRIPTION OF HISTORIC PROPERTIES*
POTENTIALLY AFFECTED BY EELV ACTIVITIES

1.0 CONCEPT A

1.1 Cape Canaveral Air Station/Kennedy Space Center, Florida

1.1.1 Archaeological Sites

8BR914 - Multi-component site associated with the St. John's II period (AD 800-1565). Associated artifacts include aboriginal ceramics, animal bone, and shell food remains.

1.1.2 Buildings And Structures

The eligibility of Space Launch Complex (SLC)-41 and Hangar J is pending.

1.2 Vandenberg Air Force Base, California

1.2.1 Archaeological Sites

SBA 534 - Site SBA 534 is located in close proximity to the proposed modifications of the intersection of Bear Creek and Coast roads. Associated artifacts include a dense scattering of lithic debris and several hammerstone fragments.

1.2.2 Buildings And Structures

SLC-3W. SLC-3W is eligible for the National Register of Historic Places (National Register) under the Cold War historic context as a highly technical and scientific facility. Contributing features include the Mobile Service Tower (MST), the umbilical mast, the retention basin and deluge channel, and Building 770. The launch operations facility and the launch vehicle support facility are also contributing as shared elements with SLC-3E.

Building 8510. Building 8510 is a contributing element to the SLC-4 (West and East) complex. As a supporting facility to this complex, Building 8510 was modified specifically to house equipment for launching Titan IV missiles.

* National Register-listed, eligible, and potentially eligible sites, buildings, and structures

2.0 CONCEPT B

2.1 Cape Canaveral Air Station, Florida

2.1.1 Archaeological Sites

SLC-37 Sites. Six sites are located near SLC-37. Three of the sites have been determined to be potentially eligible for inclusion in the National Register (described below); the remaining three sites (8BR219, 8BR237, and 8BR1636) have been determined to be ineligible (New South Associates, 1996).

8BR82A - Possible habitat or homestead site associated with the Malabar I, II, and Protohistoric Periods (BC 300-1700) and Cape Canaveral's 19th and 20th century growth. Associated artifacts include aboriginal ceramics, historic bottle and glass fragments, wire nails, and metal fragments.

8BR83 - Burial mound associated with the Malabar I and II Periods (BC 300-AD1400). The mound is approximately 75 feet in diameter and 6 feet in height. Associated artifacts include four burials, one of which contains historic glass fragments.

8BR221 - Possible habitat or homestead site associated with the Malabar II period (AD 700-1400). Associated artifacts include aboriginal and historic ceramics, shell and glass fragments, and a subsurface midden.

2.1.2 Buildings And Structures

The eligibility of Hangar C, the Missile Inert Storage (MIS) (Building 75251), and the Air Force Roll-on Roll-off Dock is pending.

2.2 Vandenberg Air Force Base, California

2.2.1 Archaeological Sites

SLC-6 Sites - Fifteen sites are located near SLC-6. Six of the sites have been determined to be eligible or potentially eligible for inclusion in the National Register (described below); five have been determined not to be eligible (SBA 1106, 1148, 2217, 2218, and 2219); the remaining four are unevaluated (SBA 1105, 1113, 1678, and 2215).

SBA 1107 - A small historical dump containing a large, whole abalone shell, stove parts, and broken dishes.

SBA 1108 - A lithic and shell process site.

SBA 1109 - A short-term occupation site with a moderate density of shell and chert debitage.

SBA 1110 - A moderate density scatter of shell and chert debitage.

[*] National Register-listed, eligible, and potentially eligible sites, buildings, and structures

SBA 1686 - A large site containing over 6,000 lithic fragments, including manos, hammerstones, large chert cores, projectile points, and knife fragments.

SBA 2032 - A short-term habitation site or seasonal residential base. Artifacts include manos, anvil stones, chert knives, and projectile point fragments.

2.2.2 Buildings And Structures

Building 8510. Building 8510 is a contributing element to the SLC-4 (West and East) complex. As a supporting facility to this complex, Building 8510 was modified specifically to house equipment for launching Titan IV missiles.

3.0 CONCEPT A/B

3.1 Cape Canaveral Air Station, Florida

3.1.1 Archaeological Sites

As described under Concepts A and B combined.

3.1.2 Buildings And Structures

As described under Concepts A and B combined.

3.2 Vandenberg Air Force Base, California

3.2.1 Archaeological Sites

As described under Concepts A and B combined.

3.2.2 Buildings And Structures

As described under Concepts A and B combined.

4.0 NO-ACTION ALTERNATIVE

4.1 Cape Canaveral Air Station, Florida

4.1.1 Archaeological Sites

None.

4.1.2 Buildings And Structures

Selection of the No-Action Alternative at Cape Canaveral AS requires the continued use of facilities that currently support medium and heavy launch vehicle programs (SLCs 17, 36, 40, and 41). Of these facilities, two, SLCs 17 and 36, have been determined to be eligible for inclusion in the National Register.

SLC-17. Constructed in 1957, SLC-17 is the oldest continuously active launch complex at Cape Canaveral AS. More satellites have been launched from this complex than from any other location in the United States, including the Thor weapons system, America’s first operational intercontinental ballistic missile (ICBM). Historic American Buildings Survey/Historic American Engineering Record (HABS/HAER) recordation of SLC-17 is in progress.

SLC-36. SLC-36 was built as an Atlas/Centaur launch facility for NASA to launch weather and communications satellites. HABS/HAER recordation has been completed.

4.2 Vandenberg AFB, California

4.2.1 Archaeological Sites

None.

4.2.2 Buildings And Structures

Selection of the No-Action Alternative at Vandenberg AFB requires the continued use of three facilities that currently support medium and heavy launch vehicle programs. Elements of all three of these facilities have been determined to be eligible for inclusion in the National Register under the Cold War historic context.

SLC-2W. SLC-2W directly supported operational missions of exceptionally important Cold War programs. Contributing elements of SLC-2W include the blockhouse, the MST, two trailer shelters, the tank farm, the fixed umbilical tower, the flame bucket/flame trench, the cableway, and several propellant transfer units.

SLC-3E. Along with SLC-3W, SLC-3E qualifies as a highly technical and scientific facility that directly supported exceptionally significant operational missions of the Cold War era. Contributing elements of SLC-3E include the launch and service facility, the MST and umbilical mast, the retention basin, and the deluge channel. SLC-3E shares two other National Register-eligible buildings with SLC-3W: the launch operations facility and the launch vehicle support facility.

SLC-4E. Along with SLC-4W, SLC-4E supported crucial military reconnaissance satellite programs from the mid-1960s to the present. Information obtained from these reconnaissance programs was used to shape America's strategic forces during the Cold War era. Contributing elements of this complex include the MST, the umbilical tower, the oxidizer scrubber, the oxidizer holding area, the fuel holding area, and the launch service building.

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APPENDIX J
AIR QUALITY METHODS OF ANALYSIS

1.0 LAUNCH SUPPORT EMISSIONS

Air quality analysis methods for launch support operations involve estimation of emissions and an assessment of emissions impact. To allow comparison of the different options (baseline, Concept A, Concept B, Concept A/B, No-Action Alternative), similar calculation methods have been used for each option to the extent feasible.

The baseline year for the air quality analysis is 1995, which is the most recent year for which detailed emissions information was available at the time of the analysis. Emissions were totaled for sources associated with the Evolved Expendable Launch Vehicle (EELV) program. Unrelated activities that occur at Cape Canaveral Air Station (AS), Florida and Vandenberg Air Force Base (AFB), California were not included in the comparisons.

The individual launch schedules (Concept A or Concept B going forward, Concept A/B going forward, and the No-Action Alternative) have different numbers of launches predicted for each year. For example, in 2007, the one-contractor option includes 29 launches, the two-contractor option includes 30 launches, and the No-Action Alternative includes 13 launches. Since the annual emission rate is dependent upon the number of launches, a direct comparison of the annual emissions from the different options can be misleading because it is not an “apples to apples” comparison. For example, the No-Action Alternative launch schedule does not include any commercial launches.

Throughout the calculations, emission calculations for volatile organic compounds (VOCs) and particulates are handled as consistently as possible. For Vandenberg AFB, several information sources identify “ROC” for reactive organic compounds, instead of “VOC” for volatile organic compounds. For all practical purposes, these two terms can be considered equivalent. The federal government generally uses the term VOC, which is defined in part in Title 40 Code of Federal Regulations (CFR) 60.2 as “any organic compound which participates in atmospheric photochemical reactions.“ The term VOC has been chosen for use in this environmental impact statement (EIS). When using emission factors that list emissions as “total hydrocarbons” and “total non-methane hydrocarbons”, “total non-methane hydrocarbons” has been utilized in this EIS as a VOC equivalent. Methane does not participate in atmospheric photochemical reactions and therefore does not fall under the definition of VOC. While there are other hydrocarbons which similarly do not fall under the VOC definition, the use of “total non-methane hydrocarbons” as a VOC equivalent is considered conservative and appropriate.

Particulate emissions are quantified as consistently as possible as particulate matter equal to or less than 10 microns in diameter (PM_{10}). In circumstances where the breakdown of particulate sizes is not known, all particulates are conservatively estimated to be PM_{10}.

Overall emission estimates were calculated as the sum of the emissions from specific activities. The methods used to estimate emissions from specific activities are described below. There are several instances where calculations were based on simplifying assumptions and engineering estimates. Many of these assumptions are listed on the spreadsheet calculations used for the EELV program, which are included in the project files. Concept A/B emissions were calculated as the sum of the emissions that would occur from each contractor’s activities.

1.1 Chemical Use (Processing)

Baseline

Both contractors supplied information on hazardous materials usage for the Atlas, Delta, and Titan vehicles. This information was used as a basis for emissions estimates. Based on the description of the chemicals and their usage, a percent VOC and a percent evaporation of that VOC were estimated.

Concept A

Concept A chemical use emissions were calculated similarly to baseline emissions.

Concept B

Concept B chemical use emissions were calculated similarly to baseline emissions.

No-Action Alternative

The No-Action Alternative chemical use emissions were calculated similarly to baseline emissions.

1.2 Hydrogen Control Flare

Because hydrogen is neither a criteria pollutant nor a hazardous air pollutant (HAP), it is not considered a contaminant of concern. Hydrogen emissions from the hydrogen control flare have not been quantified. Similarly, the only product of hydrogen combustion is water, which is not a contaminant of concern. Significant emissions from the hydrogen control flare are, therefore, only emissions from combustion of the pilot fuel. The pilot fuel is propane at Cape Canaveral AS and natural gas at Vandenberg AFB. Emissions were estimated using Compilation of Air Pollutant Emission Factors, Volume I: Stationary Point and Area Sources, 5th edition, Environmental Protection Agency (EPA) Office of Air Quality Planning and Standards, January 1995 (AP-42). Emission factors for external combustion of propane were used from Table 1.5-2, for commercial boilers. Emission factors for external combustion of natural gas were used from Tables 1.4-1 through 1.4-3, for commercial boilers. An additional quantity of nitrogen oxides (NO_x) has also been accounted for. This NO_x is generated from the reaction of atmospheric nitrogen with oxygen in the hot exhaust flame.

1.3 RP-1 (Kerosene Fuel) Fuel Handling and Storage

Emissions of RP-1 occur through working and breathing losses. Working losses include those associated with fueling of the vehicle. Emissions were estimated using AP-42 emission factors for fixed roof storage tanks (Section 7.1.3). These are the same procedures as are used in the EPA computer model TANKS.

Baseline

Tank data from the July 1996 Emission Inventory Report for Cape Canaveral AS and the 1995 Santa Barbara County Air Pollution Control District (SBCAPCD) Air Emissions Questionnaire for Vandenberg AFB were utilized. Throughputs of RP-1 were estimated based on the 1995 launch rate and the RP-10 propellant loading for each applicable vehicle.

Concept A

Tank data were obtained from construction details provided by the contractor. Throughputs of RP-1 were estimated based on the peak launch schedule and the RP-1 propellant loading for each applicable vehicle.

Concept B

Concept B launch vehicles would not utilize RP-1; therefore, no emissions from RP-1 storage and loading were included.

No-Action Alternative

Tank data were obtained from the July 1996 Emission Inventory Report for Cape Canaveral AS and the 1995 SBCAPCD Air Emissions Questionnaire for Vandenberg AFB. Throughputs of RP-1 were estimated based on the estimated peak launch rate and the RP-1 propellant loading for each applicable vehicle.

1.4 Hydrazine and Nitrogen Tetroxide (N_2O_4) Handling and Storage

Hydrazine and N_2O_4 emissions from loading activities were estimated based on an estimated loss percentage during fueling and an estimated control efficiency for the wet scrubber/oxidizer vapor control systems.

1.5 Post-Launch Cleaning and Repair

After launch, portable abrasive blasters would be used to refurbish the launch complex. Information available for abrasive blasting is limited. Available information includes a summary of the 1993 abrasive usage for Vandenberg AFB and an emission factor of 0.04 pounds particulate emissions per pound of abrasive used, a factor listed in the South Coast Air Quality Management District Permit Processing Handbook and Permit to Operate 8928 for abrasive blasting equipment at Vandenberg AFB. An overall emission factor of pounds of particulate per launch was generated from these data. For Concept A at Vandenberg AFB, a 90-percent reduction in emissions was assumed based on the use of wire brushes instead of abrasive blasters.

1.6 Truck and Automobile Operation

Total emissions for vehicular traffic were estimated using available trip and mileage estimates and emission factors from transportation emission models. For Cape Canaveral AS, the models MOBILE5 and PART5 were used to determine emission factors. For Vandenberg AFB, the models EMFAC 7f and PART5 were used. Traffic estimates were developed based on trips per day, estimated mileage, and estimated vehicle mix, as described in the transportation sections of the EIS (3.4 and 4.4). Delivery traffic was estimated based on available data from Arbogast, Kephart, Tomei, and Wildhagen, A Study of Air Emissions from Space Launch Operations: Phase II, Aerospace ATR-96(8264)-2, September 1996. Telephone conversations with Jim Kephart of Aerospace, as well as data on the baseline launch vehicles, were also used. In addition, a general estimate of emissions from specialty equipment (e.g., cranes) was included.

Similarly, emissions from traffic associated with construction activities were estimated using available trip and mileage estimates and emission factors from transportation emission models. No construction traffic was included in the baseline or No-Action Alternative.

1.7 Aircraft Operation

Aircraft would be used to deliver some launch vehicle components. Emission factors for C-141 and C-5A aircraft were calculated (in pounds) according to landing and takeoff cycle. General flight occurs outside the region of influence (above 3,000 feet). The Emission and Dispersion Modeling System (EDMS, Version 3.0) was used to generate default values for the C-141. Emissions for the C-

5A (and particulate emissions for the C-141) were calculated using the techniques and factors set forth in Calculation Methods for Criteria Air Pollutant Emission Inventories, Jagielski and O'Brien, July 1994. These calculations include approach and taxi time.

1.8 Boilers and other External Combustion Sources

Products of combustion would be emitted by boilers and other external combustion devices. Emissions were estimated based on the best available information.

Baseline

Emissions at Cape Canaveral AS from external combustion devices facility-wide are summarized in the July 1996 Radian International Air Emissions Inventory report. It is not clear how many of these sources are directly involved with the Atlas, Delta, and Titan programs (i.e., would be shut down when the programs are phased out). The calculations assume that 25 percent of emissions from boilers are associated with the Atlas, Delta, and Titan programs.

Emissions at Vandenberg AFB from external combustion devices facility-wide are summarized in the 1995 SBCAPCD Air Emissions Questionnaire. It is not clear how many of these sources are directly involved with the Atlas, Delta, and Titan programs. The calculations assume that 50 percent of emissions from boilers are associated with the Atlas, Delta, and Titan programs.

Concept A

Although specific boiler and external combustion data are not readily available, the contractor provided fuel use estimates to support utility requirements. Emissions were calculated based on this fuel use, assuming that it would occur year-round. The fuel is assumed to be combusted in one or more external combustion sources operating similarly to commercial boilers. Emissions were estimated using Compilation of Air Pollutant Emission Factors, Volume I: Stationary Point and Area Sources, 5th Edition, EPA Office of Air Quality Planning and Standards, January 1995 (AP-42). Emission factors for external combustion of propane (for Cape Canaveral AS) were taken from Table 1.5-2, for commercial boilers. Emission factors for external combustion of natural gas (for Vandenberg AFB) were taken from Tables 1.4-1 through 1.4-3, for commercial boilers.

Concept B

Estimates for emissions from specific combustion sources were provided by the contractor in the following documents: Air Emissions Information for the Delta IVB - Evolved Expendable Launch Vehicle Program, Cape Canaveral Air Station, Florida, August 1997, prepared by Cape Canaveral Air Station, The Boeing Company, and Raytheon Engineers and Constructors, and Air Emissions Information for the Delta IVB - Evolved Expendable Launch Vehicle Program, Vandenberg Air Force Base, California, August 1997, prepared by Vandenberg Air Force Base, The Boeing Company, and Raytheon Engineers and Constructors.

The estimates presented in these documents were reviewed and adjusted, as necessary, to maintain consistency with the estimates prepared for the other concepts. In general, the estimates presented in these documents use EPA AP-42 emission factors and estimates of equipment size and operating hours.

No-Action Alternative

For the No-Action Alternative, external fuel combustion and resultant emissions were assumed to be similar to those calculated for the baseline emissions.

1.9 Generators and other Internal Combustion Sources

Products of combustion would be emitted by small generators and other internal combustion devices. Emissions were estimated based on the best available information.

Baseline

Emissions from internal combustion devices facility-wide are summarized in the July 1996 Radian International Air Emissions Inventory report for Cape Canaveral AS. It is not clear how many of these sources are directly involved with the Atlas, Delta and Titan programs. The calculations assume that 5 percent of emissions from internal combustion engines would be associated with the Atlas, Delta, and Titan programs.

Emissions at Vandenberg AFB from internal combustion devices facility-wide are summarized in the 1995 SBCAPCD Air Emissions Questionnaire. It is not clear how many of these sources are directly involved with the Atlas, Delta, and Titan programs. The calculations assume that 50 percent of emissions from internal combustion engines would be associated with the Atlas, Delta, and Titan programs.

Concept A

Available data indicate that there would be a small number of internal combustion engines directly associated with Concept A activities. Emissions were estimated using AP-42 emission factors (Table 3.3-2) for emissions from diesel industrial engines. One emergency generator operating one hour per week and three small engines operating 500 hours per year were assumed.

Concept B

Estimates were taken from the same documents cited for external combustion sources (see Section 1.8 of this appendix), and were reviewed and adjusted as necessary.

No-Action Alternative

For the No-Action Alternative, internal fuel combustion and resultant emissions were assumed to be similar to those calculated for the baseline emissions.

1.10 Construction Activities

No construction activities were included in the baseline or No-Action Alternative.

All calculations were made based on average emissions per year over the construction period. Square footage for all individual structures was estimated from site plans and from facilities with similar purposes at other military installations. The surface area associated with paving modifications includes the sum of a factor for new pavement related to new building construction, plus all renovated pavement due to road and utility improvements. Sources for construction factors include The R. S. Means Building Construction Cost Data index (55th Annual Edition, 1997) and actual ratios from other government facilities including Pease, Norton and Homestead AFBs. Emissions of ROCs, NO_x, and PM_{10} have been projected based on SMAQMD Emission Estimation procedures (Sacramento Metropolitan Air Quality Management District, Air Quality Thresholds of Significance, Sacramento California, 1994). These emissions factors have been established for each of the following categories of construction activity: grading equipment, asphalt paving, stationary equipment, mobile equipment, and architectural coatings.

Emissions of VOCs, NO_x, and PM_{10} were projected based on standard estimation techniques. These emission factors were established for all three pollutant groups (where applicable) in each of the following five categories of construction activity:

- Grading Equipment
- Asphalt Paving
- Stationary Equipment
- Mobile Equipment
- Architectural Coatings.

Emissions of CO and SO2 were estimated based on the ratio of emissions for similar activities. Unmitigated or fugitive PM_{10} emissions from site preparation were calculated based on emission factors from AP-42, Sections 13.2, Fugitive Dust Sources, 13.2.3, Heavy Construction Operations, and 13.2.4, Aggregate Handling & Storage Piles. Development of these projections took into consideration all site-specific meteorological input parameters from Kennedy Space Center records and other sources.

In addition to direct construction-related emissions, there would be emissions associated with commuter traffic. Employees for construction-related activities travel by automobile, both on-site and off-site. Emissions from construction employees' automobile use were calculated using vehicle miles traveled and the emission factors available in the MOBILE 5a and PART5 computer models.

2.0 REGIONAL AIR QUALITY IMPACTS

Regional impacts were assessed by totaling the expected emissions from all sources for the baseline or peak launch year. In general, emissions are grouped into two categories: infrastructure emissions, which occur whether or not a launch is taking place and launch surge emissions, which take place once the vehicle is launched. For example, commuter traffic contributes to infrastructure emissions, while vehicle delivery contributes to launch emissions. Table J-1, presented at the end of this appendix, presents infrastructure and launch surge emissions, as well as emission totals for several launch years.

Emission factors for mobile source emissions vary depending upon the year being analyzed. The models used (MOBILE5, PART5, and EMFAC 7f) take into account improvements in the average vehicle emissions as newer, cleaner cars are purchased and older, dirtier cars are discarded. Emissions for mobile sources were, therefore, recalculated for each year analyzed.

In some instances, the maximum pollutant emission rate was predicted for different years for different pollutants. In these instances, the "peak" emissions year was taken as the year with the highest predicted NO_x emissions.

3.0 ANNUAL LAUNCH EMISSIONS

Annual launch emissions between the years 2001 and 2020 were estimated using the per launch emission estimates presented in Sections 4.10 and 4.11 of the EIS and the launch schedules presented in Table J-2, included at the end of this appendix. The annual emissions were estimated for the lower atmosphere (0-3,000 feet), the upper atmosphere (3,000-49,000 feet), and the stratosphere (49,200-164,000 feet). Emissions of criteria and toxic pollutants were estimated in the lower atmosphere, while ozone-depleting substance emissions were estimated for the upper atmosphere. The annual launch schedules for the No-Action Alternative reflect only government launches, so commercial launches of Atlas IIAs with strap-on solid rocket motors were not analyzed. The annual number of No-Action Alternative launches is generally half that of Concept A, Concept B, and Concept A/B (no commercial launches are included for the No-Action Alternative), so direct comparisons between the various launch schedules should not be made.

3.1 Vandenberg AFB Annual Emissions

The annual launch emissions released into the lower atmosphere for the No-Action Alternative and the three Proposed Action concepts are summarized in Table J-2. The NO_x emissions of the EELV concepts are several times that of the No-Action Alternative. The inter-year variability in NO_x is significant, changing by nearly 100 percent from one year to the next. The year 2008 seems to be an outlier with respect to the No-Action Alternative emissions of PM and chlorine compounds (Cl_x). Table J-2 indicates that for many years there is not a substantial difference between EELV emissions over those of the No-Action Alternative for CL_x and alumina particulates. There seems to be a surprising lack of association between No-Action Alternative NO_x emissions and those produced by EELV systems.

The annual launch emissions released into the stratosphere for the No-Action Alternative and the three EELV concepts are summarized in Table J-2. In the stratosphere, the largest sources of particulate matter (PM) and Cl_x occur for the No-Action Alternative during 2008. The peak years of the EELV program include several heavy vehicle launches, but their emissions are considerably less than those resulting from a Titan IV launch.

3.2 Cape Canaveral AS Annual Emissions

The annual launch emissions released into the lower atmosphere, upper atmosphere, and stratosphere for the No-Action Alternative and the three EELV concepts are summarized in Table J-2. As mentioned previously, less NO_x are associated with the No-Action Alternative, due, in part, to fewer launches (no commercial launches were analyzed for the No-Action Alternative). The influence of the Titan IVB emissions of particles and Cl_x is evident in the table. The large inter-annual variations in the No-Action Alternative emissions are present in all species except carbon monoxide (CO).

The advantages of Concept A over the other concepts is clearly noted for alumina particulates and CL_x, where the No-Action Alternative shows a peak in emissions of such pollutants several times greater than in the EELV vehicles, despite the fewer launches scheduled.

4.0 MODELING OF AIR QUALITY IMPACTS

The modeling of launch emissions impacts on the ambient air quality concentrations in the lower troposphere was conducted using the Rocket Exhaust Effluent Diffusion Model (REEDM) air quality dispersion model, which predicts incremental increases in concentrations of criteria and toxic pollutants. The chemicals of concern include the criteria pollutants NO_x (nitric oxide [NO] and/or nitrogen dioxide [NO_2]) and CO, as well as the toxic or irritant pollutants ammonia (NH_3), hydrochloric acid (HCl), and the hydrazine compounds unsymmetrical dimethylhydrazine (UDMH), monomethyl hydrazine (MMH), and hydrazine (N_2H_4). Concentrations are predicted as a layer average concentration over the first 3,000 meters. The reported concentration time-averaging is for 30 minutes. Since launches are intermittent, hourly concentrations were treated as half of the 30-minute average, the 8-hour CO is 1/16th, and a peak daily average was estimated as 1/48th of the peak 30-minute concentration.

The meteorological inputs for REEDM are based on a vertical sampling of the atmosphere taken by a balloon launched at 1500 Eastern Standard Time (EST) on November 1, 1995 (profile 184) from

Vandenberg AFB. The winds, which are relatively light, range in speed from 1-2 miles per second over the lowest 3,000 meters. Wind direction is from the northwest; however, since the same profile is used for both sites, only the downwind distance to the maximum concentration was examined. Critical fenceline distances for pads at both sites is on the order of 5 kilometers or less. The REEDM model was exercised with receptor arcs at 1-kilometer intervals from 1 to 30 kilometers.

The REEDM modeling should be interpreted as a screening tool since a systematic search for the worst-case meteorology was not conducted at either launch site. The use of a single meteorological profile is a simplification, because the surface meteorology at the two sites is different, as indicated in Section 3.0 of the EIS.

In some, but not all cases, both a Vandenberg AFB and Cape Canaveral AS simulation were run for each launch vehicle. The differences in the predictions are minor owing to similar meteorological inputs. There are two launch modes: a normal flight which produces only NO_x and in some cases CO, and an abort/deflagration mode in which the launch vehicle is destroyed. This latter mode produces the greatest emissions of pollutants, particularly in the case where upper stages utilizing solid or hypergolic propellants are used.

4.1 Ambient Concentrations, Concept A

For aborted launches, the total emissions resulting from the deflagration fireball were estimated from the fate mass fractions and the total load of propellants and oxidants (Table J-3).

Table J-3. Summary of Emissions Resulting from Launch Failure, Concept A (in tons)

	MLV-A	MLV-D	HLV-L	HLV-G
CO	16.94	16.94	50.82	50.82
NO_x	6.07	0.0	6.07	0.0
HCl	0.0	0.0	0.0	0.0
N_2O_4	0.0	0.0	0.0	0.0
N_2H_4	0.0	0.0	0.0	0.0
UDMH	0.0	0.0	0.0	0.0
MMH	0.72	0.0	0.72	0.0
VOC[(a)]	12.25	12.25	36.75	36.75

Note: (a) The estimate of VOCs is based on the residual RP-1 that is vaporized.
CO = carbon monoxide
HCl = hydrochloric acid
HLV = heavy lift variant
MLV = medium lift variant
MMH = monomethyl hydrazine
N_2H_4 = anhydrous hydrazine
N_2O_4 = nitrogen tetroxide
NO_x = nitrogen oxides
RP-1 = rocket propellant-1 (kerosene fuel)
UDMH = unsymmetrical dimethylhydrazine
VOC = volatile organic compound

As described earlier, REEDM produces peak puff and 30-minute average concentration estimates, which are converted to hourly and daily concentrations. Tables for peak hourly and daily CO and NO_x predictions were produced. Rather than producing tables for each toxic hydrazine compound, the concentrations were summed for all hydrazine compounds. Separate tables for NH_3 and HCl peak 30-minute concentrations have been compiled where relevant.

The CO-predicted incremental concentrations for Concept A vehicles is presented in Table J-3. This table indicates that since the launch is a transient source, the 8-hour average concentration increment is a small fraction of the National Ambient Air Quality Standards (NAAQS) of 9 parts per million (ppm).

Table J-4. Summary of REEDM-Predicted Ambient Air Concentration Increments for CO During Aborted Launches, Concept A

	Distance to maximum concentration (km)	Peak 30-minute average concentration increment (ppm)	Peak 8-hour average concentration increment (ppm)	Peak daily average concentration increment (ppm)
MLV-D	4	3.61	0.225	0.075
MLV-A	4	2.08	0.130	0.043
HLV-L	5	6.61	0.413	0.137
HLV-G	5	3.91	0.244	0.081

CO = carbon monoxide
HLV = heavy lift variant
km = kilometers
MLV = medium lift variant
ppm = parts per million
REEDM = Rocket Exhaust Effluent Diffusion Model

The NAAQS for NO_x is an annual standard and is not affected by the transient launch releases. The California Ambient Air Quality Standards (CAAQS) has an hourly NO_2 standard of 0.25 ppm. For conservative purposes, it was assumed that all NO in NO_x is converted to NO_2 rapidly. The REEDM-predicted NO_x ($NO + NO_2$) incremental concentrations resulting from the abort of Concept A vehicles are summarized in Table J-5.

Table J-5. Summary of REEDM-Predicted Ambient Air Concentration Increments for NO_x During Aborted Launches, Concept A

	Distance to maximum concentration (km)	Peak 30-minute average concentration increment (ppm)	Peak 1-hour average concentration increment (ppm)	Peak daily average concentration increment (ppm)
MLV-D	4	0.227	0.114	0.0047
MLV-A	NA	NA	NA	NA
HLV-L	6	0.139	0.057	0.0029
HLV-G	NA	NA	NA	NA

HLV = heavy lift variant
km = kilometers
MLV = medium lift variant
NA = not applicable
NO_X = nitrogen oxides
ppm = parts per million
REEDM = Rocket Exhaust Effluent Diffusion Model

For the MLV-A and HLV-G, REEDM did not predict NO or NO_2 incremental concentrations during an abort. The results indicate that the maximum predicted NO_x concentration increment is half of the hourly NO_2 standard.

Chlorine in the form of HCl would not be employed for any of the Concept A launch vehicles. NH_3 was predicted by REEDM for the MLV-A and HLV-G abort scenarios. Table J-6 provides the resulting peak and 30-minute average concentrations.

The incremental concentrations are typical of rural ambient concentrations and would not pose any short-term health hazards.

Table J-6. Summary of REEDM-Predicted Ambient Air Concentration Increments for NH_3 During Aborted Launches, Concept A

	Distance to maximum concentration (km)	Peak 30-minute average concentration increment (ppm)	Peak puff concentration increment (ppm)
MLV-D	NA	NA	NA
MLV-A	4-5	0.004	0.013
HLV-L	NA	NA	NA
HLV-G	5-6	0.003	0.006

HLV = heavy lift variant
km = kilometers
MLV = medium lift variant
NA = not applicable
NH_3 = ammonia
ppm = parts per million
REEDM = Rocket Exhaust Effluent Diffusion Model

Hydrazine compound concentrations were estimated by REEDM for each launch vehicle and are summarized in Table J-7.

Table J-7. Summary of REEDM-Predicted Ambient Air Concentration Increments for Hydrazine Compounds During Aborted Launches, Concept A

	Distance to maximum concentration (km)	Peak 30-minute average concentration increment (ppm)	Peak puff concentration increment (ppm)
MLV-D	4	0.025	0.079
MLV-A	4	0.0	0.001
HLV-L	5-6	0.015	0.038
HLV-G	NA	0.0	0.0

HLV = heavy lift variant
km = kilometers
MLV = medium lift variant
NA = not applicable
ppm = parts per million
REEDM = Rocket Exhaust Effluent Diffusion Model

The maximum concentrations of hydrazine compounds were predicted for the smaller launch vehicle, possibly because of the increased buoyancy of this vehicle, making the final centerline height larger and the ground-level concentrations smaller.

4.2 Ambient Concentrations, Concept B

Emissions from aborted launches were estimated as described in Section 4.1 of this appendix (Table J-8).

Table J-8. Summary of Emissions Resulting from Launch Failure, Concept B (in tons)

	DIV-S	DIV-M	DIV-M+	DIV-H
CO	0.0	0.0	0.0	0.0
NO_x	0.23	0.0	0.66	0.0
HCl	0.0	0.0	8.80	0.0
N_2H_4	0.005	0.005	0.005	0.01
MMH	0.0	0.0	0.0	0.0
UDMH	0.005	0.0	0.0	0.0
PM	0.0	0.0	17.09	0.0
VOC	0.0	0.0	0.0	0.0

CO = carbon monoxide
DIV-H = heavy launch vehicle
DIV-M = medium launch vehicle
DIV-M+ = medium launch vehicle with solid rocket motor strap-ons
DIV-S = small launch vehicle
HCl = hydrochloric acid
MMH = monomethyl hydrazine
N_2H_4 = anhydrous hydrazine
NO_x = nitrogen oxides
PM = particulate matter
UDMH = unsymmetrical dimethylhydrazine
VOC = volatile organic compound

As described earlier, REEDM produces peak puff and 30-minute average concentration estimates, which are converted to hourly and daily concentrations. Tables for peak hourly and daily CO and NO_x predictions were produced. Rather than producing tables for each toxic hydrazine compound, the concentrations were summed for all hydrazine compounds. Separate tables for NH_3 and HCl peak 30-minute concentrations have been compiled where relevant.

The CO-predicted incremental concentrations for Concept B vehicles is presented in Table J-9.

Table J-9. Summary of REEDM-Predicted Ambient Air Concentration Increments for CO During Aborted Launches, Concept B

	Distance to maximum concentration (km)	Peak 30-minute average concentration increment (ppm)	Peak 8-hour average concentration increment (ppm)
DIV-S	5	0.011	0.0007
DIV-M	NA	NA	NA
DIV-M+	4	0.011	0.0007
DIV-H	NA	NA	NA

CO = carbon monoxide
DIV-H = heavy launch vehicle
DIV-M = medium launch vehicle
DIV-M+ = medium launch vehicle with solid rocket motor strap-ons
DIV-S = small launch vehicle
km = kilometers
NA = not applicable
ppm = parts per million
REEDM = Rocket Exhaust Effluent Diffusion Model

As Table J-9 indicates, given that the launch is a transient source, the 8-hour average concentration increment is a minuscule fraction of the NAAQS of 9 ppm. The concentrations are so small that a daily average concentration increment was not estimated.

The NAAQS for NO_x is an annual standard and is not affected by the transient launch releases. The CAAQS has an hourly NO_2 standard of 0.25 ppm. For conservative purposes, it was assumed that all NO in NO_x is converted to NO_2 rapidly. Table J-10 summarizes the REEDM-predicted NO_x (NO + NO_2) incremental concentrations resulting from the abort of Concept B vehicles.

Table J-10. Summary of REEDM-Predicted Ambient Air Concentration Increments for NO_x During Aborted Launches, Concept B

	Distance to maximum concentration (km)	Peak 30-minute average concentration increment (ppm)	Peak 1-hour average concentration increment (ppm)	Peak daily average concentration increment (ppm)
DIV-S	5	0.105	0.053	0.0022
DIV-M	NA	NA	NA	NA
DIV-M+	NA	NA	NA	NA
DIV-H	NA	NA	NA	NA

DIV-H = heavy launch vehicle
DIV-M = medium launch vehicle
DIV-M+ = medium launch vehicle with solid rocket motor strap-ons
DIV-S = small launch vehicle
km = kilometers
NA = not applicable
NO_x = nitrogen oxides
ppm = parts per million
REEDM = Rocket Exhaust Effluent Diffusion Model

NO or NO_2 incremental concentrations during an abort were predicted by REEDM only for the DIV-S vehicle configuration. Results indicate that the maximum NO_x concentration increment is about one-fifth of the hourly NO_2 standard.

Chlorine in the form of HCl was predicted for the DIV-M+ (commercial only) configurations. Table J-11 summarizes the REEDM concentration increment predictions.

Table J-11. Summary of REEDM-Predicted Ambient Air Concentration Increments for HCl During Aborted Launches, Concept B

	Distance to maximum concentration (km)	Peak 30-minute average concentration increment (ppm)	Peak puff concentration increment (ppm)
DIV-M+	4	0.007	0.023

DIV-M+ = medium launch vehicle with solid rocket motor strap-ons
HCl = hydrochloric acid
km = kilometers
ppm = parts per million
REEDM = Rocket Exhaust Effluent Diffusion Model

Peak puff concentrations are a small fraction of the Occupational Safety and Health Administration (OSHA) Permissible Exposure Level (PEL) ceiling limit of 5 ppm.

NH_3 was predicted by REEDM for all Concept B abort scenarios. Table J-12 presents the resulting peak and 30-minute average concentrations.

Table J-12. Summary of REEDM-Predicted Ambient Air Concentration Increments for NH_3 During Aborted Launches, Concept B

	Distance to maximum concentration (km)	Peak 30-minute average concentration increment (ppm)	Peak puff concentration increment (ppm)
DIV-S	4-5	0.041	0.124
DIV-M	4	0.002	0.005
DIV-M+	4	0.002	0.005
DIV-H	5	0.002	0.005

DIV-H = heavy launch vehicle
DIV-M = medium launch vehicle
DIV-M+ = medium launch vehicle with solid rocket motor strap-ons
DIV-S = small launch vehicle
HCl = hydrochloric acid
km = kilometers
NH_3 = ammonia
ppm = parts per million
REEDM = Rocket Exhaust Effluent Diffusion Model

For the DIV-S abort scenario, REEDM predicted larger concentrations than for all other vehicles. The incremental concentrations for all other launch configurations are typical of rural ambient concentrations and would not pose any short-term health hazards.

Table J-13 summarizes hydrazine compound concentrations estimated by REEDM for each Concept B launch vehicle. The maximum concentrations of hydrazine compounds resulting from the use of the DIV-S with its hypergolic upper stage are larger than for any other Concept B vehicle.

Table J-13. Summary of REEDM-Predicted Ambient Air Concentration Increments for Hydrazine Compounds During Aborted Launches, Concept B

	Distance to maximum concentration (km)	Peak 30-minute average concentration increment (ppm)	Peak puff concentration increment (ppm)
DIV-S	4-5	0.009	0.028
DIV-M	NA	0.0	0.0
DIV-M+	NA	0.0	0.0
DIV-H	NA	0.0	0.0

DIV-H = heavy launch vehicle
DIV-M = medium launch vehicle
DIV-M+ = medium launch vehicle with solid rocket motor strap-ons
DIV-S = small launch vehicle
HCl = hydrochloric acid
km = kilometers
ppm = parts per million
REEDM = Rocket Exhaust Effluent Diffusion Model

4.3 Estimation of Emissions Resulting from Launch Failure

The REEDM model utilizes information from a fireball chemical model (Brady et al., 1997) to estimate the fate of the propellants and oxidants from a vehicle that is deliberately destroyed. The chemicals suffer several different fates, including:

- accelerated combustion reaction
- thermal decomposition
- vaporization
- atmospheric combustion
- chemical conversion.

Each fate produces a different mass budget of pollutant products, many of which are chemicals of concern. By analyzing REEDM input and output, a simple matrix model was developed to account for the fuel mass that is converted into emitted chemicals of concern. The matrix model provides a more efficient method of analyzing launch failures for different vehicles and documenting the results.

The information in the matrix model is contained in three tables. The first (Table J-14) consists of a two-dimensional array of vehicle type by fuel type; the second (Table J-15) is another two-dimensional array, linking fuel type to fuel fates. Several interesting features that are relevant to air quality are evident in Table J-16. First, the vaporization of RP-1 would result in substantial VOC emissions. Second, significant toxic hydrazine concentrations may be released from upper stages upon deflagration.

Once the fate pathways for a fuel have been assigned, the fractions of chemicals of concern generated for each fate and each fuel must be allocated. Table J-14 specifies that allocation for each of three fates (decomposition and combustion do not contribute to generation of chemicals of concern) in Table J-14. The matrix model was successful in reproducing REEDM output for all chemicals of concern, with the exception of predicted ammonia emissions. In several instances, the REEDM model predicted ammonia emissions for fuels that provided no logical pathway to produce ammonia. No attempt was made to replicate those results in the matrix model.

Table J-14. Fuel-Vehicle Array for Deflagration Emission Model

	Fuel type (lbs)								
Vehicle Name	LO_2	LH_2	RP-1	N_2O_4	UDMH	N_2H_4	MMH	PBAN	HTPB
DELTA II	147,360	0	65,679	8,648	2,276	0	0	232,182	0
ATLAS II	266,350	5,900	108,000	0	0	0	0	0	0
ATLAS II AS	266,350	5,900	108,000	0	0	0	0	96,000	0
TITAN IV	37,466	7,489	0	272,300	72,850	72,850	0	1,203,930	0
TITAN IVB	37,466	7,489	0	272,300	72,850	72,850	0	1,360,788	0
TITAN II	0	0	0	207,802	55,733	55,733	0	0	0
DIV-S	450,000	63,000	0	700	175	175	0	0	0
DIV-M	481,538	68,665	0	0	0	160	0	0	0
DIV-M+	481,538	68,665	0	0	0	160	0	0	103,564
DIV-H	1,399,164	197,672	0	0	0	320	0	0	0
MLV-A	450,000	0	175,000	18,688	0	0	10,260	0	0
MLV-D	485,504	6,639	175,000	0	0	0	0	0	0
HLV-G	1,385,504	6,639	525,000	0	0	0	0	0	0
HLV-L	1,350,000	0	525,000	18,688	0	0	10,260	0	0

DIV-H = heavy launch vehicle
DIV-M = medium launch vehicle
DIV-S = small launch vehicle
HLV = heavy lift variant
HTPB = hydroxyl-terminated polybutadiene
N_2H_4 = anhydrous hydrazine
LH_2 = liquid hydrogen
LO_2 = liquid oxygen
MLV = medium lift variant
MMH = monomethyl hydrazine
NO_x = nitrogen oxides
N_2O_4 = nitrogen tetroxide
PBAN = polybutadiene-acrylic acid acrylonitrile terpolymer (binder material)
RP-1 = rocket propellant-1 (kerosene fuel)
UDMH = unsymmetrical dimethylhydrazine

Table J-15. Fractional Mass Fates for Each Fuel as a Function of Fate

Fuel	Fate				
	Decomposed	Vaporized	Reacted	Converted	Combusted
LO_2	0.0	0.56	0.44	0.0	0.0
LH_2	0.0	0.56	0.44	0.0	0.0
RP-1	0.42	0.14	0.44	0.0	0.0
N_2O_4	0.07	0.0	0.22	0.71	0.0
UDMH	0.72	0.06	0.22	0.0	0.0
N_2H_4	0.72	0.06	0.22	0.0	0.0
MMH	0.63	0.14	0.23	0.0	0.0
PBAN	0.0	0.0	1.00	0.0	0.0
HTPB	0.0	0.0	1.00	0.0	0.0

HTPB = hydroxyl-terminated polybutadiene
LH_2 = liquid hydrogen
LO_2 = liquid oxygen
MMH = monomethyl hydrazine
N_2H_4 = anhydrous hydrazine
N_2O_4 = nitrogen tetroxide
PBAN = polybutadiene-acrylic acid acrylonitrile terpolymer (binder material)
RP-1 = rocket propellant-1 (kerosene fuel)
UDMH = unsymmetrical dimethylhydrazine

Table J-16. Mass Fractions of Chemicals of Concern for Each Fuel/Fate Pathway

	Chemical of Concern						
Fate/Fuel Chemical	RP-1	N_2O_4	UDMH	N_2H_4	MMH	PBAN	HTPB
VAPORIZED							
VOC	1.0	0.0	0.0	0.0	0.0	0.0	0.0
N_2O_4	0.0	1.0	0.0	0.0	0.0	0.0	0.0
UDMH	0.0	0.0	1.0	0.0	0.0	0.0	0.0
H_2N_2	0.0	0.0	0.0	1.0	0.0	0.0	0.0
MMH	0.0	0.0	0.0	0.0	1.0	0.0	0.0
NO_x	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PM	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Al	0.0	0.0	0.0	0.0	0.0	0.19	0.19
NH_4CLO_4	0.0	0.0	0.0	0.0	0.0	0.69	0.69
HCl	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NH_3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
REACTED							
VOC	0.0	0.0	0.0	0.0	0.0	0.0	0.0
N_2O_4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
UDMH	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_2N_2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MMH	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NO_x	0.0	0.012	0.012	0.012	0.012	0.014	0.014
PM	0.0	0.0	0.0	0.0	0.0	0.33	0.33
CO	0.44	0.0	0.0	0.0	0.0	0.0	0.0
Al	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NH_4CLO_4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HCl	0.0	0.0	0.0	0.0	0.0	0.17	0.17
NH_3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CONVERTED							
VOC	1.0	0.0	0.0	0.0	0.0	0.0	0.0
N_2O_4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
UDMH	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_2N_2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MMH	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NO_x	0.0	1.0	0.0	0.0	0.0	0.0	0.0
PM	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Al	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NH_4CLO_4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HCl	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NH_3	0.0	0.0	0.0	0.0	0.0	0.0	0.0

VOC = volatile organic compound
N_2O_4 = nitrogen tetroxide
UDMH = unsymmetrical dimethylhydrazine
MMH = monomethyl hydrazine
NO_x = nitrogen oxides
PM = particulate matter
CO = carbon monoxide
Al = aluminum
NH_4ClO_4 = ammonium perchlorate
HCl = hydrochloric acid
NH_3 = ammonia
N_2H_4 = anhydrous hydrazine

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TABLE J-1

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TABLE J-2

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APPENDIX K
CLEAN AIR ACT CONFORMITY APPLICABILITY ANALYSIS
VANDENBERG AIR FORCE BASE, CALIFORNIA

Purpose

The U.S. Air Force is required to perform a formal air conformity applicability analysis to determine whether the Evolved Expendable Launch Vehicle (EELV) program at Vandenberg Air Force Base (AFB), California complies with the Environmental Protection Agency (EPA) Final Conformity Rule, 40 Code of Federal Regulations (CFR) 93, Subpart B (for federal agencies) and 40 CFR 51, Subpart W (for state requirements) of the amended Clean Air Act (CAA).

Background

The U.S. EPA has issued regulations clarifying the applicability of and procedures for ensuring that federal activities comply with the amended CAA. The EPA Final Conformity Rule implements Section 176(c) of the CAA, as amended in 42 U.S. Code (USC) 7506(c). This rule was published in the Federal Register on November 30, 1993, and took effect on January 31, 1994.

The EPA Final Conformity Rule requires all federal agencies to ensure that any federal action resulting in nonattainment criteria pollutant emissions conforms with an approved or promulgated state implementation plan (SIP) or federal implementation plan (FIP). Conformity means compliance with a SIP/FIP's purpose of attaining or maintaining the National Ambient Air Quality Standards (NAAQS). Specifically, this means ensuring that the federal action will not: (1) cause a new violation of the NAAQS; (2) contribute to any increase in the frequency or severity of violations of existing NAAQS; or (3) delay the timely attainment of any NAAQS interim milestones, or other attainment milestones. NAAQS are established for six criteria pollutants: ozone (O_3), carbon monoxide (CO), particulate matter equal to or less than 10 microns in diameter (PM_{10}), nitrogen dioxide (NO_2), sulfur dioxide (SO_2), and lead (Pb). The current standards apply to federal actions in NAAQS nonattainment or maintenance areas only.

Status

The proposed EELV program would be implemented at Vandenberg AFB in Santa Barbara County, California. Air quality management in Santa Barbara County is under the jurisdiction of the Santa Barbara County Air Pollution Control District (SBCAPCD), the California Air Resources Board (CARB), and the U.S. EPA, Region 9. All sections of SBCAPCD's Rule 702 were adopted verbatim from the federal General Conformity regulation (58 Federal Regulation [FR] 63214, November 30, 1993), except for provision 51.860, preambled below.

51.860 Mitigation of Air Quality Impact.

(A) Any measures that are intended to mitigate air quality impact must be identified (including the identification and quantification of all emission reductions claimed) and the process for implementation (including any necessary funding of such measures and tracking of such emission reductions) and enforcement of such measures must be described, including an implementation schedule counting explicit timelines for implementation.

(B) Prior to determining that a Federal action is in conformity, the Federal agency making the conformity determination must obtain written commitments from the appropriate persons or agencies to implement any mitigation measures which are identified as conditions for making conformity determinations. Such written commitments shall describe such mitigation measures and the nature of the commitment, in a manner consistent with paragraph (A).

(C) Persons or agencies voluntarily committing to mitigation measures to facilitate positive conformity determinations must comply with the obligations of such commitments.

(D) In instances where the Federal agency is licensing, permitting or otherwise approving the action of another governmental or private entity, approval by the Federal agency must be conditioned on the other entity meeting the mitigation measures set forth in the conformity determination, as provided in paragraph (A).

(E) When necessary because of changed circumstances, mitigation measures may be modified so long as the new mitigation measures continue to support the conformity determination in accordance with 51.858 and 51.859 and this section. Any proposed change in the mitigation measures is subject to the reporting requirements of section 51.856 and the public participation requirements of section 51.857.

(F) After a State revises its SIP to adopt its general conformity rules and EPA approves that SIP revision, any agreements, including mitigation measures, necessary for a conformity determination will be both State and Federally enforceable. Enforceability through the applicable SIP will apply to all persons who agree to mitigate direct and indirect emissions associated with a Federal Action for a conformity determination. Adopted 10/20/94.

Other than the above listed, Santa Barbara County is following federal implementation guidelines. The area of Santa Barbara County containing Vandenberg AFB complies with state and federal standards for SO_2, NO_2, CO, and lead. The entire Santa Barbara County is classified as in moderate nonattainment for ozone. The classification of nonattainment for PM_{10} is by state standards only. The SBCAPCD did not meet its emission goals for moderate nonattainment for ozone. As a result, the district is in the process of reclassification to ozone serious nonattainment in 1998. The Santa Barbara County nonattainment area ozone reclassification proposed rule was published in the Federal Register as 40 CFR Part 81 on September 2, 1997. The EPA anticipates the reclassification to be effective as early as February 1998, and no later than November 1999.

The EPA Final Conformity Rule requires that total direct and indirect emissions of nonattainment criteria pollutants, including ozone precursors (volatile organic compounds [VOCs] and nitrogen oxides [NO_x]), be considered in determining conformity. The rule does not apply to actions where the total direct and indirect emission of nonattainment criteria pollutants do not exceed threshold levels for criteria pollutants established in 40 CFR 93.135(b). Ongoing activities are exempt from the rule as long as there is no increase in emissions above the de minimis levels specified in the rule. Table K-1 presents the de minimis threshold level of nonattainment areas. This analysis compares air emissions totals to both de minimis thresholds to take into consideration the ozone reclassification status of Santa Barbara County from moderate to serious nonattainment.

Table K-1. De Minimis Threshold in Nonattainment Areas (tons per year)

Pollutant	Degree of Nonattainment Level	De Minimis[(a)(b)]
Ozone (VOCs and NO_x)	**Moderate**	**100**
	Serious	**50**
	Severe	25
	Extreme	10
VOCs	Marginal	50
NO_x	Marginal	100
Carbon Monoxide	All	100

Particulate Matter	Moderate Serious	100 70
SO_2 or NO_2	All	100
Lead	All	25

Note: [(a)] The de minimis threshold level for ozone in Santa Barbara County is being reclassified to 50 tons per year (applicable no later than November 1999).
[(b)] Numbers in bold reflect de minimis thresholds used in this analysis.

NO_2 = nitrogen dioxide
NO_x = nitrogen oxides
SO_2 = sulfur dioxide
VOC = volatile organic compound

Source: Santa Barbara County Air Pollution Control District - Regulation VII, Rule 702

In addition to meeting de minimis requirements, a federal action must not be considered a regionally significant action. A federal action is considered regionally significant when the total emissions from the action equal or exceed 10 percent of the air quality control area's emission inventory for any criteria pollutant. If a federal action meets de minimis requirements and is not considered a regionally significant action, then it is exempt from further conformity analyses pursuant to 40 CFR 93.153(c).

Summary of Air Pollutant Emissions and Regulatory Standards

This section provides a summary of the Santa Barbara County non-compliance pollutant standards as defined in the 1994 Air Quality Management Plan for Santa Barbara County.

As discussed in the air quality section of the environmental impact statement (EIS) for the EELV program, Santa Barbara County is currently in violation of the state PM_{10} standard and the state and federal ozone standards. Exceedances of the annual state standard for PM_{10} have occurred only at the downtown Santa Maria monitoring station, while the 24-hour PM_{10} state standard (50 micrograms per cubic meter [$\mu g/m^3$] for California and 150 $\mu g/m^3$ for the federal standard) violations are dispersed throughout the county. Since Vandenberg AFB is located in Santa Barbara County, which does not exceed federal PM_{10} standards and is unclassified by federal standards, a PM_{10} analysis is not included as part of this Air Conformity Applicability Analysis.

Both the federal CAA and the California State CAA set up a method for classifying areas according to severity of ozone. These classifications determine regulatory requirements and target dates for ozone standard attainment. Five classifications have been mandated for ozone: marginal, moderate, serious, severe, and extreme. The current federal ozone standard is 0.12 parts per million. An area is designated as being in nonattainment if it violates the standard more than three times in 3 years at a single monitoring station. As mentioned in the EIS, the EPA has approved a new ozone standard. The new standard and implementation measures have not yet been approved in the Santa Barbara County Air Quality Management Plan or SIP.

For federal actions, an air conformity applicability analysis and (if needed) a conformity determination are required when the total of direct and indirect emissions of a criteria pollutant in a nonattainment or maintenance area caused by the federal action equals or exceeds the de minimis thresholds. The nonattainment pollutants included in this analysis are the ozone precursors (measured by VOCs and NO_x).

Emission Modeling

A total of direct and indirect emissions (increases and decreases) from the EELV program concepts was estimated using methods similar to those presented in the EIS. The following conformity-related emission sources were considered in the emission estimates: launch emissions, operational direct and indirect emissions, construction-related emissions, and mobile source (direct and indirect) emissions from operations. The emission estimates for this project were calculated for the following years: baseline year 1995; construction years 1998, 1999, 2000, 2001, 2002; EELV operation years 2001 and 2002; Air Quality Management Plan Conformity Growth year 2006; and peak launch years 2007 and 2014. The baseline year, consistent with the EIS for the air conformity applicability analysis, is 1995, which is the most recent year for which detailed emissions information was available at the time of the analysis. Emissions were totaled for sources associated with the EELV program; unrelated activities that occur at Vandenberg AFB were not included in the comparison.

Further review of the definition of "indirect emissions" in the General Conformity Rule has resulted in modifications to the sources addressed in the "Direct and Indirect Emissions" portion of the protocol. Indirect emissions are defined in 40 CFR 93.152 as emissions of a criteria pollutant which: (1) are caused by a federal action, but may occur later in time and/or may be farther removed in distance from the action itself but are still reasonably foreseeable, and (2) the federal agency can practicably control and will maintain control over due to a continuing program responsibility.

The air quality modeling analysis required under the conformity rule must be based on the applicable air quality model, data bases, and other requirements specified in the "Guideline on Air Quality Models (Revised)" (1986), including supplements (EPA Publication No. 450/2-78-027R) and the Air Force Conformity Guide Handbook. Models used in this applicability analysis to determine air emissions resulting from the EELV program at Vandenberg AFB include the EMFAC 7(f), the state of California-approved model for motor vehicles, emission factors of aircraft associated with EELV component deliveries from Emissions and Dispersion Modeling System (EDMS, Version 3.0), and Calculation Methods for Criteria Air Pollutant Emission Inventories (Jagielski and O'Brien, 1994). Emissions of VOCs and NO_x generated by facility construction activities were projected based on Sacramento Metropolitan Air Quality Management District (SMAQMD) factors (Sacramento Metropolitan Air Quality Management District, Air Quality Thresholds of Significance, Sacramento, California, 1994). These emission factors have been established for each of the following categories of construction activity:

- Grading Equipment: Emissions in the grading phase are primarily associated with the exhaust from large earth-moving equipment.

- Asphalt Paving: VOC emissions in the asphalt paving phase are released through the evaporation of solvents contained in paving materials.

- Stationary Equipment: Emissions from stationary equipment occur when machinery such as generators, gas-powered saws, and other similar equipment are used at the construction site.

- Mobile Equipment: Mobile equipment includes fork lifts, dump trucks, excavators, etc.

- Architectural Coatings: VOCs are released through the evaporation of solvents that are contained in paints, varnishes, primers, and other surface coatings.

- Commuter Automobiles: Commuter traffic emissions are generated from commuter trips to and from the work site by construction employees. The average vehicle ridership number

(1.5 persons per vehicle) from the California Environmental Quality Act (CEQA) Handbook was applied.

Tables and Emission Data

Emission calculations for VOCs were performed as consistently as possible. Several information sources identify “ROC,” for reactive organic compounds, instead of “VOC,” for volatile organic compounds. For all practical purposes, these two terms can be considered equivalent. The federal government generally uses the term VOC, which is defined, in part, in 40 CFR 60.2, as “any organic compound which participates in atmospheric photochemical reactions.” The term VOC has been chosen for use in this document. When using emission factors that list emissions as “total hydrocarbons” and “total non-methane hydrocarbons,” the document uses “total non-methane hydrocarbons” as a VOC equivalent. Methane does not participate in atmospheric photochemical reactions and therefore does not fall under the definition of VOC. While there are other hydrocarbons that similarly do not fall under the definition of VOC, the use of “total non-methane hydrocarbons” as a VOC equivalent is considered conservative and appropriate.

The emissions of ozone precursors (VOCs and NO_x) and other criteria pollutants that would result from construction and implementation of the EELV program are shown in Tables K-2 through K-5.

Table K-2. Comparison of EELV Annual Emission Inventory at Vandenberg AFB, Concept A (tons/year)

Pollutants	Emission Sources	1995	1998	1999	2000	2001	2002	2006	2007	2014
VOCs	Baseline	36.3								
	Construction-Related									
	Grading Equipment			-	0.7	0.2	-	-	-	-
	Asphalt Paving		-	-	0.0	0.0	-	-	-	-
	Stationary Equipment		-	-	2.0	1.5	0.2	-	-	-
	Mobile Equipment		-	-	1.9	1.5	0.2	-	-	-
	Architectural Coatings (Non-Residential)		-	-	3.2	2.4	0.4	-	-	-
	Commuter Automobiles		-	-	2.6	2.0	0.5	-	-	-
	Total Construction Emissions		-	-	10.4	7.7	1.3	-	-	-
	Operation-Related									
	Program Launches					-	-	-	-	-
	Preparation and Assembly					3.0	4.5	6.0	7.5	7.5
	Mobile Sources					3.3	3.4	2.4	2.2	1.3
	Point Sources					0.3	0.3	0.3	0.3	0.3
	Total Project Emissions		-	-	-	6.6	8.2	8.7	10.0	9.1
	Emission Decreases from No-Action Alternative		-	-	-	(2.4)	(3.5)	(4.7)	(5.3)	(5.3)
	Total Annual Emissions	**36.3**	**-**	**-**	**10.4**	**11.9**	**6.0**	**4.0**	**4.7**	**3.7**
NO_x	Baseline	39.8								
	Construction-Related									
	Grading Equipment		-	-	4.7	1.4	-	-	-	-
	Asphalt Paving		-	-	-	-	-	-	-	-
	Stationary Equipment		-	-	1.6	1.3	0.2	-	-	-
	Mobile Equipment		-	-	19.1	14.7	2.3	-	-	-
	Architectural Coatings (Non-Residential)		-	-	-	-	-	-	-	-
	Commuter Automobiles		-	-	2.6	2.1	0.5	-	-	-
	Total Construction Emissions		-	-	28.1	19.5	3.0	-	-	-
	Operation-Related									
	Program Launches					1.9	2.9	3.8	4.8	4.8
	Preparation and Assembly									
	Mobile Sources					4.0	4.6	4.3	4.4	3.7
	Point Sources					4.5	4.5	4.5	4.5	4.5
	Total Project Emissions		-	-	-	10.4	12.0	12.6	13.7	13.1
	Emission Decreases from No-Action Alternative		-	-	-	(10.1)	(11.4)	(12.6)	(13.7)	(13.6)
	Total Annual Emissions	**39.8**	**-**	**-**	**28.1**	**19.8**	**3.6**	**(0.0)**	**(0.0)**	**(0.6)**

NO_x = nitrogen oxides
VOC = volatile organic compound

Table K-3. Comparison of EELV Annual Emission Inventory at Vandenberg AFB, Concept B (tons/year)

Pollutants	Emission Sources	1995	1998	1999	2000	2001	2002	2006	2007	2014
VOCs	Baseline	36.3								
	Construction-Related									
	Grading Equipment		-	1.4	-	-	-	-	-	-
	Asphalt Paving		-	0.1	0.2	-	-	-	-	-
	Stationary Equipment		0.2	2.6	13.1	0.4	-	-	-	-
	Mobile Equipment		0.2	2.5	12.5	0.4	-	-	-	-
	Architectural Coatings (Non-Residential)		0.3	3.0	9.7	0.4	-	-	-	-
	Commuter Automobiles		0.2	1.4	3.7	1.2	-	-	-	-
	Total Construction Emissions		0.9	11.0	39.2	2.4	-	-	-	-
	Operation-Related									
	Program Launches					-	-	-	-	-
	Preparation and Assembly					2.6	4.0	5.3	6.6	6.6
	Mobile Sources					10.5	10.3	7.4	6.7	3.9
	Point Sources					0.5	0.5	0.5	0.5	0.5
	Total Project Emissions		-	-	-	13.6	14.7	13.1	13.8	11.0
	Emission Decreases from No-Action Alternative		-	-	-	(2.4)	(3.5)	(4.7)	(5.3)	(5.3)
	Total Annual Emissions	**36.3**	**0.9**	**11.0**	**39.2**	**13.6**	**11.2**	**8.5**	**8.5**	**5.6**
NO_x	Baseline	39.8								
	Construction-Related									
	Grading Equipment		-	9.1	-	-	-	-	-	-
	Asphalt Paving		-	-	-	-	-	-	-	-
	Stationary Equipment		0.2	2.1	10.7	0.3	-	-	-	-
	Mobile Equipment		2.1	24.8	125.8	3.5	-	-	-	-
	Architectural Coatings (Non-Residential)		-	-	-	-	-	-	-	-
	Commuter Automobiles		0.2	1.2	3.4	0.2	-	-	-	-
	Total Construction Emissions		2.5	37.2	139.9	4.0	-	-	-	-
	Operation-Related									
	Program Launches					3.2	2.2	4.6	5.4	5.4
	Preparation and Assembly									
	Mobile Sources					11.8	11.9	11.1	10.8	8.7
	Point Sources					4.2	4.2	4.2	4.2	4.2
	Total Project Emissions		-	-	-	19.1	18.3	19.9	20.4	18.3
	Emission Decreases from No-Action Alternative		-	-	-	(10.1)	(11.4)	(12.6)	(13.7)	(13.6)
	Total Annual Emissions	**39.8**	**2.5**	**37.2**	**139.9**	**13.0**	**6.9**	**7.3**	**6.7**	**4.7**

NO_x = nitrogen oxides
VOC = volatile organic compound

Table K-4. Comparison of EELV Annual Emission Inventory at Vandenberg AFB, Concept A/B (tons/year)

Pollutants	Emission Sources	1995	1998	1999	2000	2001	2002	2006	2007	2014
VOCs	Baseline	36.3								
	Construction-Related									
	Grading Equipment		-	1.4	0.7	0.2	-	-	-	-
	Asphalt Paving		-	0.1	0.2	0.0	-	-	-	-
	Stationary Equipment		0.2	2.6	15.1	1.9	0.2	-	-	-
	Mobile Equipment		0.2	2.5	14.4	1.9	0.2	-	-	-
	Architectural Coatings (Non-Residential)		0.3	3.0	12.9	2.8	0.4	-	-	-
	Commuter Automobiles		0.2	1.4	6.3	3.2	0.5	-	-	-
	Total Construction Emissions		0.9	11.0	49.6	10.1	1.3	-	-	-
	Operation-Related									
	Program Launches					-	-	-	-	-
	Preparation and Assembly					1.3	2.0	3.3	9.9	4.6
	Mobile Sources					12.3	11.2	7.4	6.8	3.8
	Point Sources					0.8	0.8	0.8	0.8	0.8
	Total Project Emissions		-	-	-	14.5	14.0	11.5	17.5	9.3
	Emission Decreases from No-Action Alternative		-	-	-	(2.4)	(3.5)	(4.7)	(5.3)	(5.3)
	Total Annual Emissions	**36.3**	**0.9**	**11.0**	**49.6**	**22.2**	**11.8**	**6.8**	**12.3**	**4.0**
NO_x	Baseline	39.8								
	Construction-Related									
	Grading Equipment		-	9.1	4.7	1.4	-	-	-	-
	Asphalt Paving		-	-	-	-	-	-	-	-
	Stationary Equipment		0.2	2.1	12.3	1.6	0.2	-	-	-
	Mobile Equipment		2.1	24.8	144.9	18.2	2.3	-	-	-
	Architectural Coatings (Non-Residential)		-	-	-	-	-	-	-	-
	Commuter Automobiles		0.2	1.2	6.1	2.3	0.5	-	-	-
	Total Construction Emissions		2.5	37.2	168.0	23.4	3.0	-	-	-
	Operation-Related									
	Program Launches					2.4	2.8	4.5	7.9	5.5
	Preparation and Assembly									
	Mobile Sources					13.6	13.1	11.3	11.7	9.0
	Point Sources					8.7	8.7	8.7	8.7	8.7
	Total Project Emissions		-	-	-	24.8	24.6	24.5	28.2	23.2
	Emission Decreases from No-Action Alternative		-	-	-	(10.1)	(11.4)	(12.6)	(13.7)	(13.6)
	Total Annual Emissions	**39.8**	**2.5**	**37.2**	**168.0**	**37.9**	**16.2**	**11.8**	**14.5**	**9.5**

NO_x = nitrogen oxides
VOC = volatile organic compound

Table K-5. Comparison of Pollutant Emissions to Emissions Inventory

Analysis

The total of direct and indirect emissions resulting from EELV construction activities is illustrated in Table K-6. A temporary increase in emissions resulting from construction activities for the year 2000 (Concepts B and A/B) exceeds both de minimis thresholds for NO_x. Assuming the reclassification of the area is enacted, the VOC emissions for Concept A/B are too close to the 50-ton-per-year de minimis threshold to ignore. A formal air conformity determination will be required for EELV construction activities, as required by the CAA, 40 CFR Part 93. Resultant direct and indirect emissions occurring during EELV program operations are illustrated in Tables K-2, K-3, and K-4. A decrease in emissions is expected by full employment in 2007. This decrease in emissions is a result of the replacement of Atlas IIA, Delta II, and Titan IVB launch programs with the EELV program. Normal operations for the EELV program would not exceed any de minimis thresholds. During the peak launch operation years of 2007 and 2014, it is anticipated that a slight increase in emissions would occur due to temporary launch technical crews associated with the launch activities. These temporary technical crews would consist of 14 to 18 persons per launch, who would remain in the county for up to 14 days per launch. During the peak launch years, increases in direct and indirect emissions from temporary technical crews are not anticipated to cross the de minimis threshold for nonattainment pollutants. Total emissions from each concept of the EELV program are less than 10 percent of the Santa Barbara County emission inventory. Therefore, the EELV program is not regionally significant. The Air Force is required to determine whether the EELV construction processes for Concept B and Concept A/B conform with the SIP. A formal Air Conformity Determination will be prepared as required by the CAA, 40 CFR Part 93.

Table K-6. Comparison of EELV Annual Emission Inventory with De Minimis Threshold, Vandenberg AFB

Pollutant			Emissions (tons/year)							
			1998	1999	2000	2001	2002	2006	2007	2014
VOCs										
	Moderate Ozone Nonattainment Threshold	100								
	Serious Ozone Nonattainment Threshold	50								
	Concept A		0.0	0.0	10.4	11.9	6.0	4.0	4.7	3.7
	Concept B		0.9	11.0	39.2	13.6	11.2	8.5	8.5	5.6
	Concept A/B		0.9	11.0	49.6	22.2	11.8	6.8	12.3	4.0
NO_x										
	Moderate Ozone Nonattainment Threshold	100								
	Serious Ozone Nonattainment Threshold	50								
	Concept A		0.0	0.0	28.1	19.8	3.6	0.0	0.0	0.0
	Concept B		2.5	37.2	139.9	13.0	6.9	7.3	6.7	4.7
	Concept A/B		2.5	37.2	168.0	37.9	16.2	11.8	14.5	9.5

Note: Bold numbers exceed de minimis threshold.

NO_x = nitrogen oxides

VOC= volatile organic compound

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